

AD-A086 526

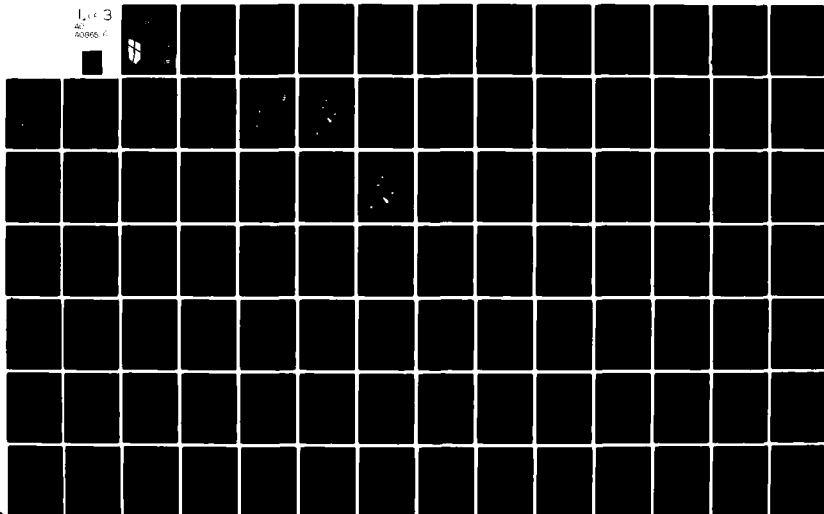
CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/6 6/6
GUIDELINES FOR TERRESTRIAL ECOSYSTEM SURVEY.(U)
MAY 80 W D SEVERINGHAUS

UNCLASSIFIED

CERL-TR-N-89

NL

1 of 3
AD
A0866 6



construction
engineering
research
laboratory



United States Army
Corps of Engineers
... Serving the Army
... Serving the Nation

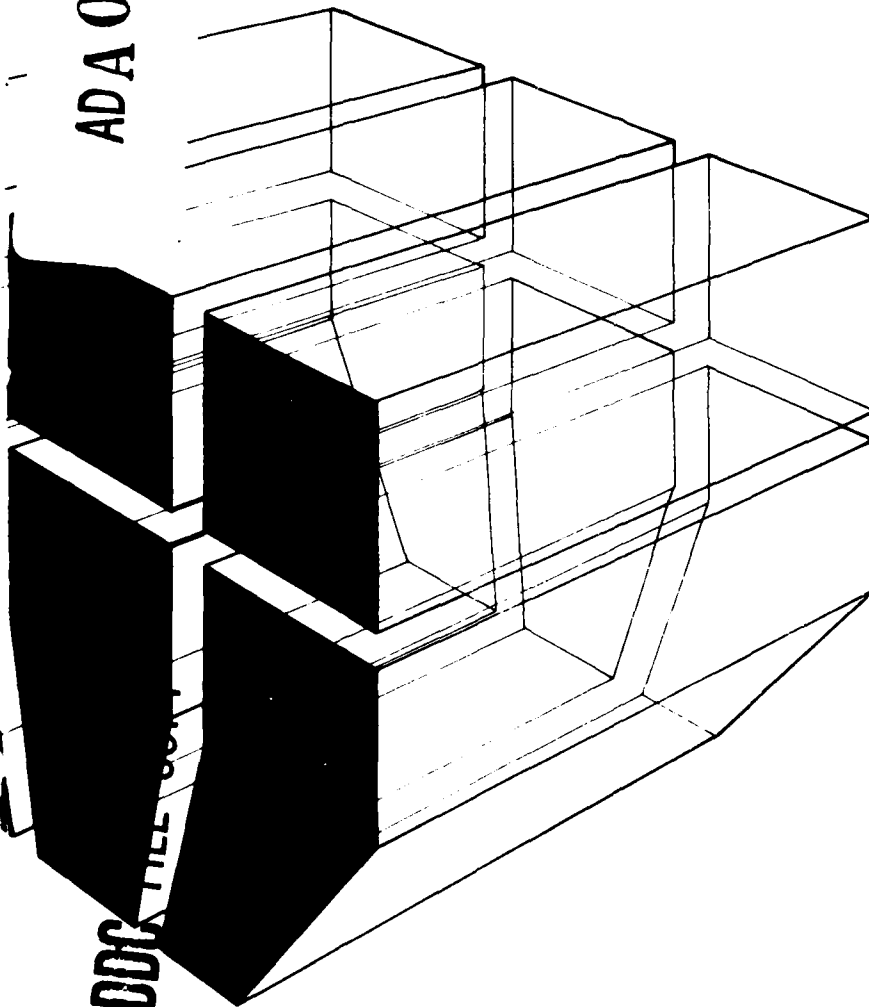
TECHNICAL REPORT N-89
May 1980

12

LEVEL

GUIDELINES FOR TERRESTRIAL
ECOSYSTEM SURVEY

ADA 086526



by
W. D. Severinghaus

DTIC
ELECTE
JUL 15 1980



MAY 1980

Approved for public release; distribution unlimited

80 7 14 05

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official indorsement or approval of the use of such commercial products. The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

***DESTROY THIS REPORT WHEN IT IS NO LONGER NEEDED
DO NOT RETURN IT TO THE ORIGINATOR***

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 CERL-TR-N-89	2. GOVT ACCESSION NO. AD-A086526	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 GUIDELINES FOR TERRESTRIAL ECOSYSTEM SURVEY.	5. TYPE OF REPORT & PERIOD COVERED 9 FINAL rept.	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR 10 D. Severinghaus William	8. CONTRACT OR GRANT NUMBER(s) ILIR	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005, Champaign, IL 61820	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE May 1980	13. NUMBER OF PAGES 211
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 218	15. SECURITY CLASS. (of this report) Unclassified	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service Springfield, VA 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) environmental impact statements ecology ecosystems surveys 405279 Dm		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → This report provides guidelines that will enable Army installations to compile and maintain enough information on flora and fauna to produce satisfactory environmental impact assessments and statements. The report outlines a three-stage method for data acquisition and contains appendices listing literature resources and specialists. By completing Stage I, users create a series of maps, overlays, and tables that give an estimate of the amount of habitat, types of vegetation, and types of →		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

~~UNCLASSIFIED~~

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block 20 continued.

↓ animals existing on the installation. Stage II involves a field verification of the information from Stage I. Stage III requires the explicit documentation of population densities and other ecological parameters of the various organisms on the installation. ↑

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

FOREWORD

This document was prepared by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL) under the In-Laboratory Independent Research (ILIR) program.

Dr. E. Novak is Acting Chief of EN. COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

Accession For	
NTIS	ORNL
DDC TAB	
Unpublished	
Justification	
By	
Date	
Initials	
Signature	
A	

CONTENTS

	<u>Page</u>
DD FORM 1473	1
FOREWORD	3
LIST OF TABLES AND FIGURES	5
1 INTRODUCTION.....	7
Background	7
Objective	7
Approach	8
Use of the Guidelines	8
2 STAGE I. ESTIMATION OF TERRESTRIAL BIOTA.....	9
Vegetation	9
Animals	21
3 STAGE II. VERIFICATION OF TERRESTRIAL BIOTA.....	33
Species Familiarization	33
Site Selection	34
Field Survey	34
Specimen Collection	38
Other Methods of Verification	38
4 STAGE III. QUANTIFICATION OF TERRESTRIAL BIOTA.....	40
Site Selection	40
Vegetation	40
Mammals	43
Birds	48
5 CONCLUSIONS AND RECOMMENDATIONS.....	53
APPENDIX A: Selected Literature References	54
APPENDIX B: List of Museums and Specialists	145
APPENDIX C: Prism Method of Forest Sampling	157
APPENDIX D: Alternate Sampling Methods	164
APPENDIX E: Analyzing Bird Transect Counts	170
APPENDIX F: Estimating Breeding Season Bird Densities	172
APPENDIX G: Test Grid and Recapture Points	187
APPENDIX H: Recording and Analysis of Field Observations	190
DISTRIBUTION	

TABLES

<u>Number</u>		<u>Page</u>
1	Vegetational Composite	20
2	Mammals	23
3	Vegetational Composite With List of Mammals	29
4	Trees' Basal Area	42
5	Basal Area Results	43
6	Vegetation Less Than 2 Meters In Height -- Raw Data	44
7	Vegetation Less Than 2 Meters In Height -- Results	44
8	The Schnabel Method of Estimating Populations	47

FIGURES

1	Tree Types	10
2	Tree Canopy Closure	11
3	Shrub Types	12
4	Shrub Crown Cover	13
5	Herb Types	14
6	Herb Ground Cover	15
7	Aquatic Relationships	16
8	List of Mammal Species at Fort Knox	29
9	Habitat Areas -- Squirrel	30
10	Habitat Areas -- Muskrat	31
11	Critical Bird Species at Fort Knox	32
12	Survey Transect Determination	35
13	Data Card	46

FIGURES (Cont'd)

	<u>Page</u>
14 Grid for Field Observations	50
C1 "In," "Out," and "Borderline" Trees	162
C2 The Correct Way to Employ the Abney and the Wedge Prism	162
D1 Use of Biltmore Stick for Making Tree Height Measurements	166
D2 Determining Crown Radius for Trees	166
D3 Grid System for Traps	169
D4 Mammal Population	169

GUIDELINES FOR TERRESTRIAL ECOSYSTEM SURVEY

1 INTRODUCTION

Background

The National Environmental Policy Act of 1969 requires that the probable impact from major actions of U.S. Government agencies be analyzed. These analyses are prepared and presented as a portion of Environmental Assessments (EA) or Environmental Impact Statements (EIS), and usually require that a considerable amount of time and money be spent surveying biota -- the flora and fauna -- of the proposed area of impact. The major problem is the shortage of time available to do necessary fieldwork. Generally Government agencies attempt to avoid this difficulty by hiring experts from a variety of disciplines (e.g., botany, entomology, herpetology, mammalogy, ornithology) to perform field surveys. Even with this expertise, however, the ecological data usually consist of a "laundry list" of those species that are readily identifiable, controversial, or economically important. Information about population is limited to categories such as abundant, common, uncommon, and rare. These categories are seldom quantifiable, are the interpretation of the individual researcher, and are not comparable among researchers.

A final problem is that during the course of the survey, some uncommon or rare -- and perhaps controversial -- species can be missed, as shown by the discovery of the Furbish Lousewort in New England and the Snail Darter in Tennessee after construction was partially completed.

Objective

The objective of this report is to present guidelines to help Army installations compile and maintain enough information on the biota of the installation to produce satisfactory input for EA/EIS. Following the procedures outlined here will allow installations to: (1) reduce expenditures by using technician-level personnel, since persons with minimal expertise can collect the required data; and (2) generate precise quantitative data on the location of various types of habitat, the acreage of each type, and the number of individuals of each animal and plant species per unit area in each habitat.

Approach

The terrestrial ecosystem survey guidelines in this report are products of basic ecological research to identify cause-effect relationships between Army activities and resulting impacts on terrestrial ecosystems. As part of this research it was necessary to acquire ecological field data. Both by examining the literature on ecological survey methods, and by actually using various methods in the field, survey techniques were developed for ecological sampling so that quantitative data could be obtained on habitats, their locations, acreage, and species composition.

Use of the Guidelines

These techniques are part of a three-stage process. While the information obtained at the end of any one stage will be useful, the system will be even more accurate and useful as additional stages are completed. Of course, completion of each successive stage will also require increasing investments of time and money.

After finishing Stage I, users of this report will have produced a series of maps, overlays, and tables that will give an estimate of the amount of habitat, types of vegetation, and types of animals existing on the installation. Stage II will involve a field verification of the information obtained in Stage I. Stage III will involve the explicit documentation of population densities and other ecological parameters of the various organisms on the installation.

Before starting this program, investigators should study the entire report because some stages will require field work. If field work is necessary, it might be more efficient to conduct different portions of this program simultaneously.

2 STAGE I. ESTIMATION OF TERRESTRIAL BIOTA

Stage I is essentially a compilation of available information requiring little, if any, field work. Completion of this stage will provide a series of maps, overlays, and tables that will give an estimate of the amount of habitat, types of vegetation, and types of animals existing on the installation. Investigators will compile a list of species that might exist on the installation, and will determine a range in possible population levels for some species. Although some of this information is already available at Army installations and is being used for the preparation of EA or EIS, Stage I will give more detailed information than is presently in the files of most installations. The information gathered in Stage I will be compiled in two formats: overlays to an aerial photograph, and a series of descriptive tables.

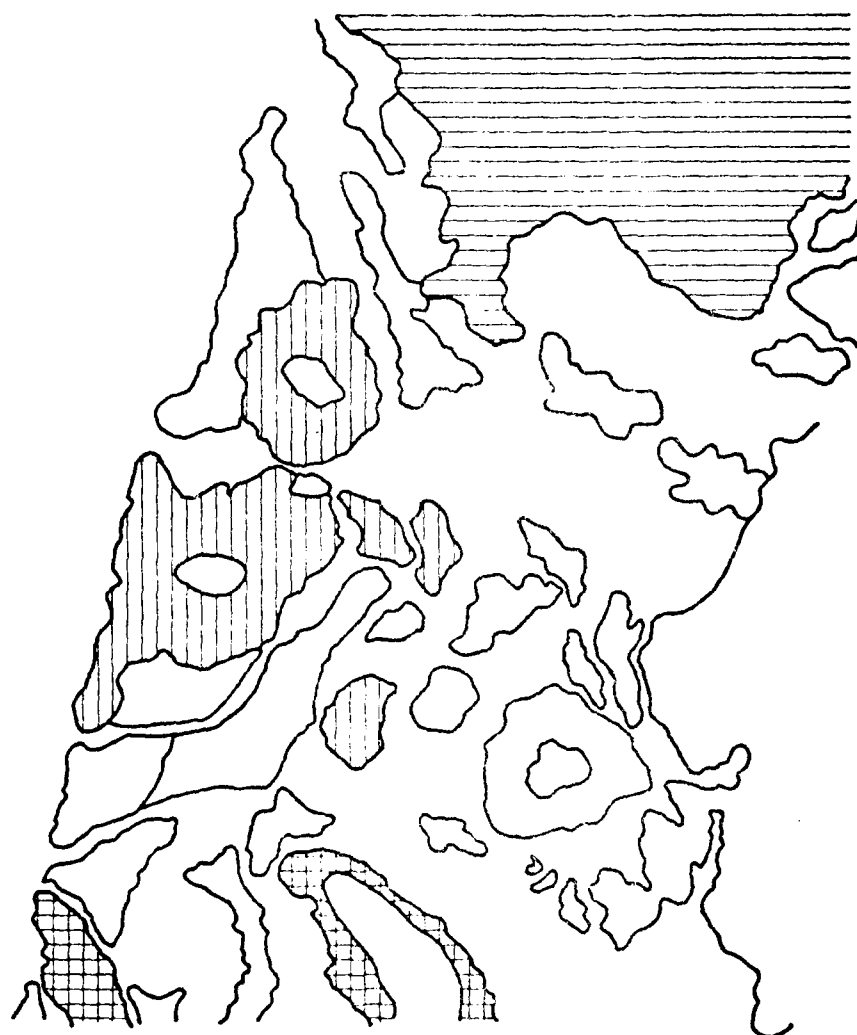
Vegetation

The first step in estimating vegetation parameters on the installation is to obtain United States Geological Survey (USGS) topographic maps of scale 1:24,000 and aerial photographs of approximately 1:15,000. These items will be used throughout the study as the base for overlays. The literature available on the trees, shrubs, and herbs should be acquired (Appendix A lists much of the literature available). Soil survey maps and terrain analysis reports should be obtained, if available. Most of the mapping can be completed by examining aerial photographs occasionally supplemented with a brief field examination. Accurate completion of the vegetation mapping is very important because the faunal mapping and some detailed vegetational mapping will be based on these overlays.

The following discussion is a step-by-step presentation of the procedures to be followed for vegetation mapping and tabulation. First, *Vegetational Characteristics Mapping* discusses general definitions to be used for vegetational mapping. Then *Vegetation Characteristics Description* explains how to tabulate information gathered through mapping.

Vegetational Characteristics Mapping

The base for overlays should be an aerial photograph of a scale approximately 1:15,000. Production of the overlays themselves should conform to the guidelines described below; this will result in six overlays, one each for tree type, tree canopy closure, shrub type, shrub crown cover, herb type, and herb ground cover; see Figures 1 through 6 for examples. A seventh overlay should be produced on the aquatic relationships of the installation (Figure 7). This can be done by transferring the appropriate information from the 1:24,000 topographic maps to an overlay. Thus, by placing the overlays on the aerial photograph, users



 Evergreen

 Deciduous

 Mixed

Figure 1. Tree types.

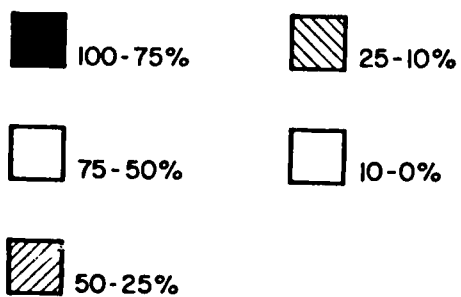
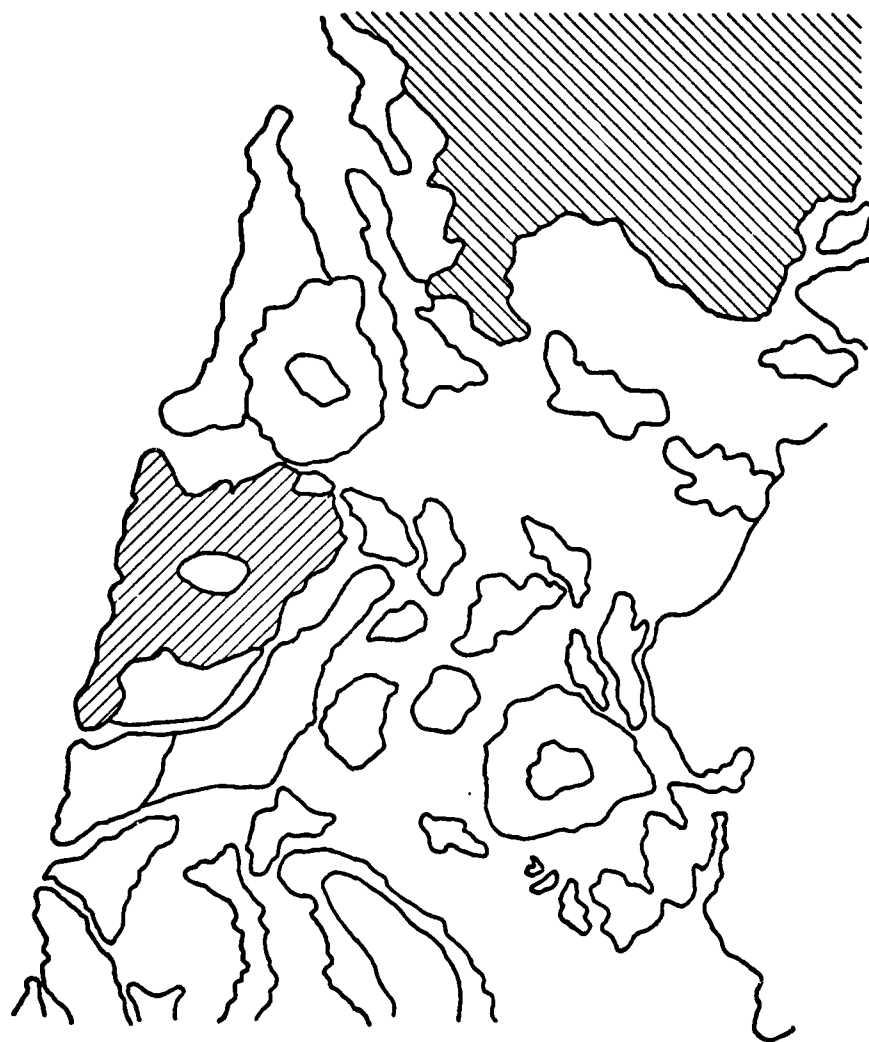


Figure 2. Tree canopy closure.

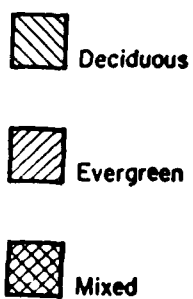
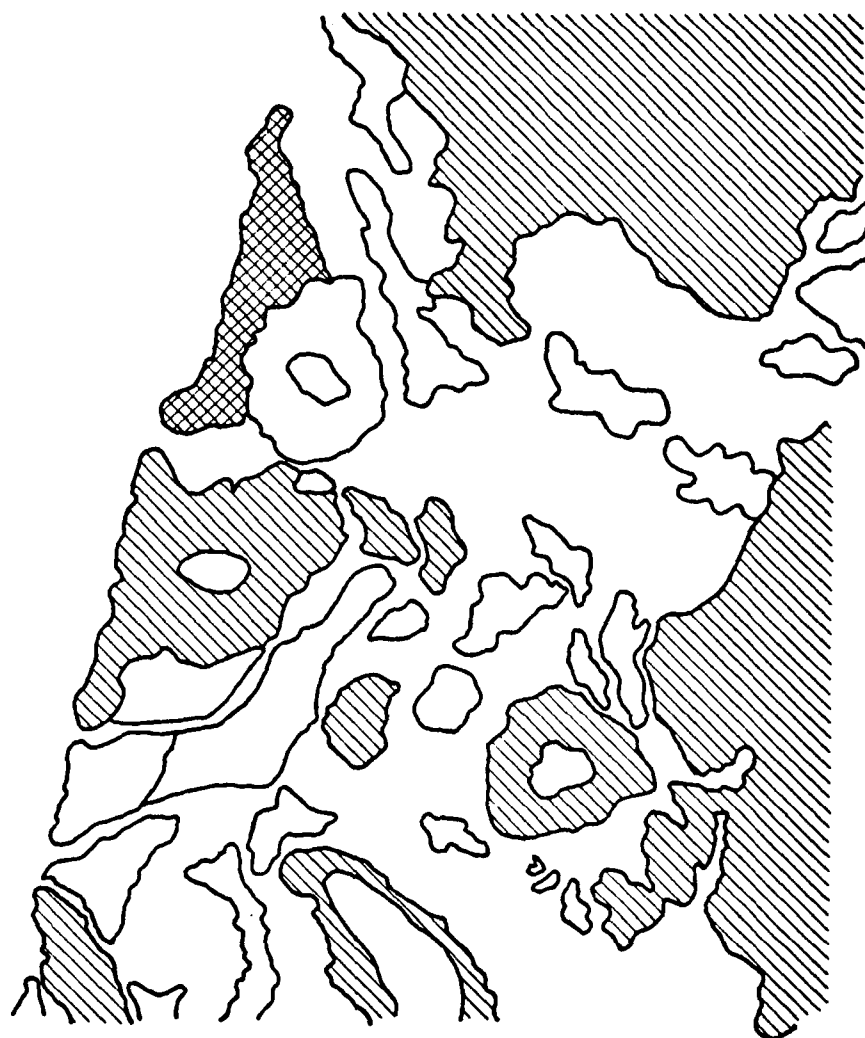


Figure 3. Shrub types.

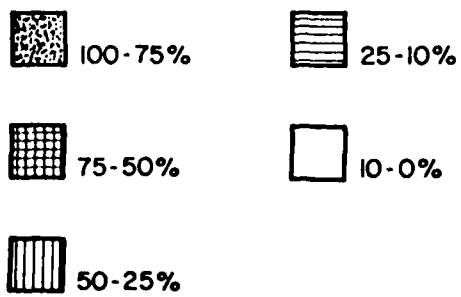
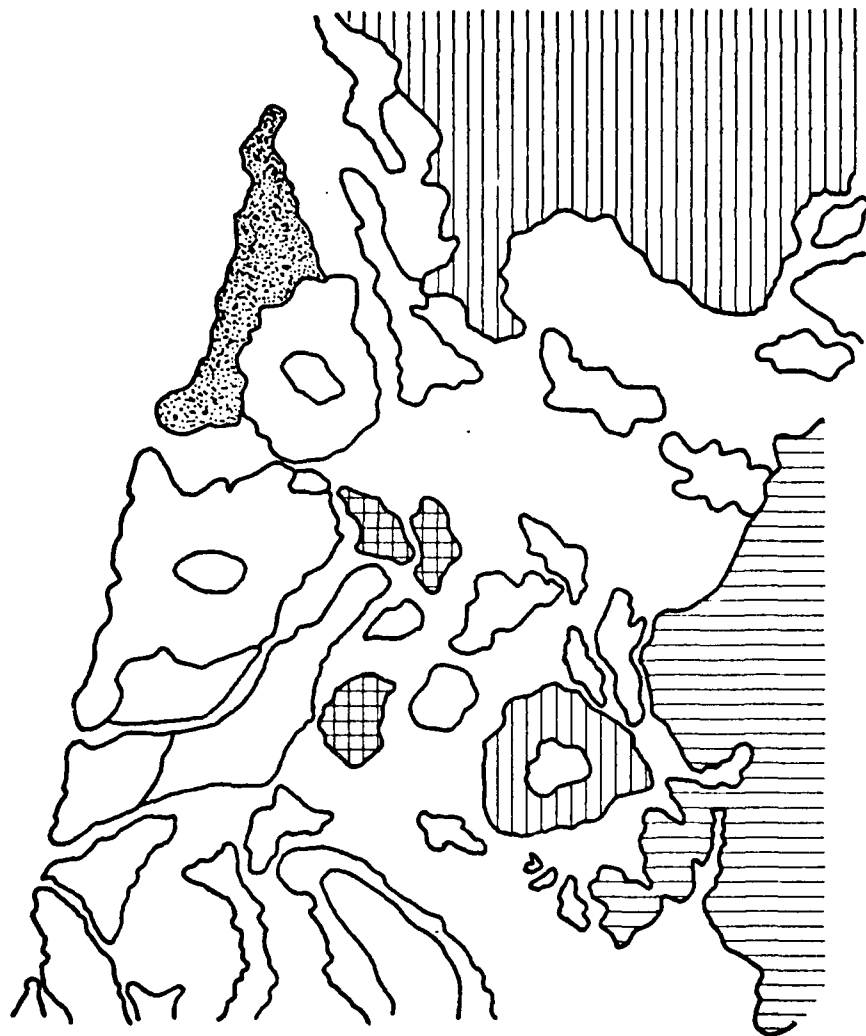


Figure 4. Shrub crown cover.

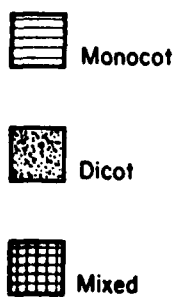
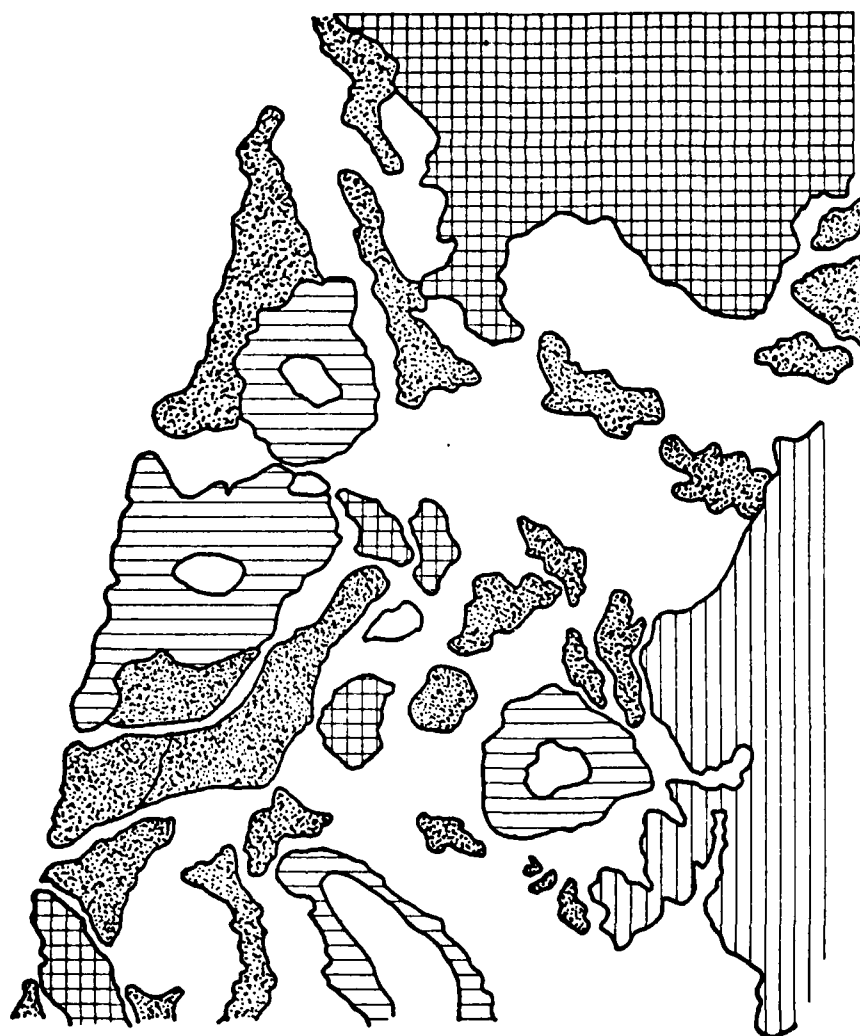


Figure 5. Herb types.

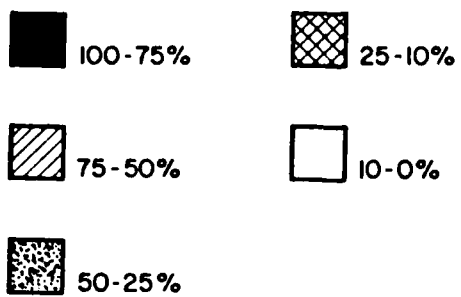
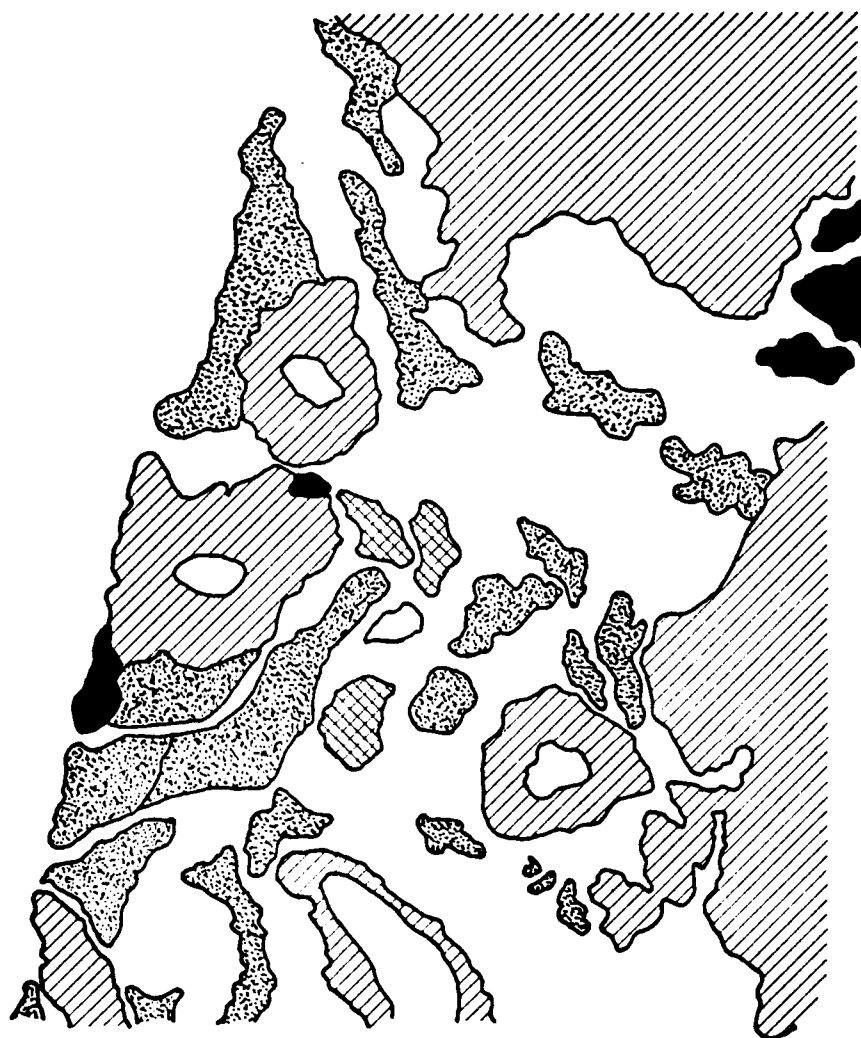


Figure 6. Herb ground cover.

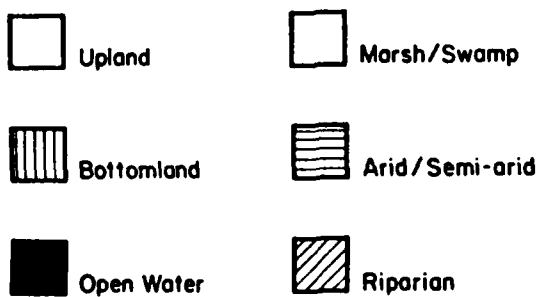
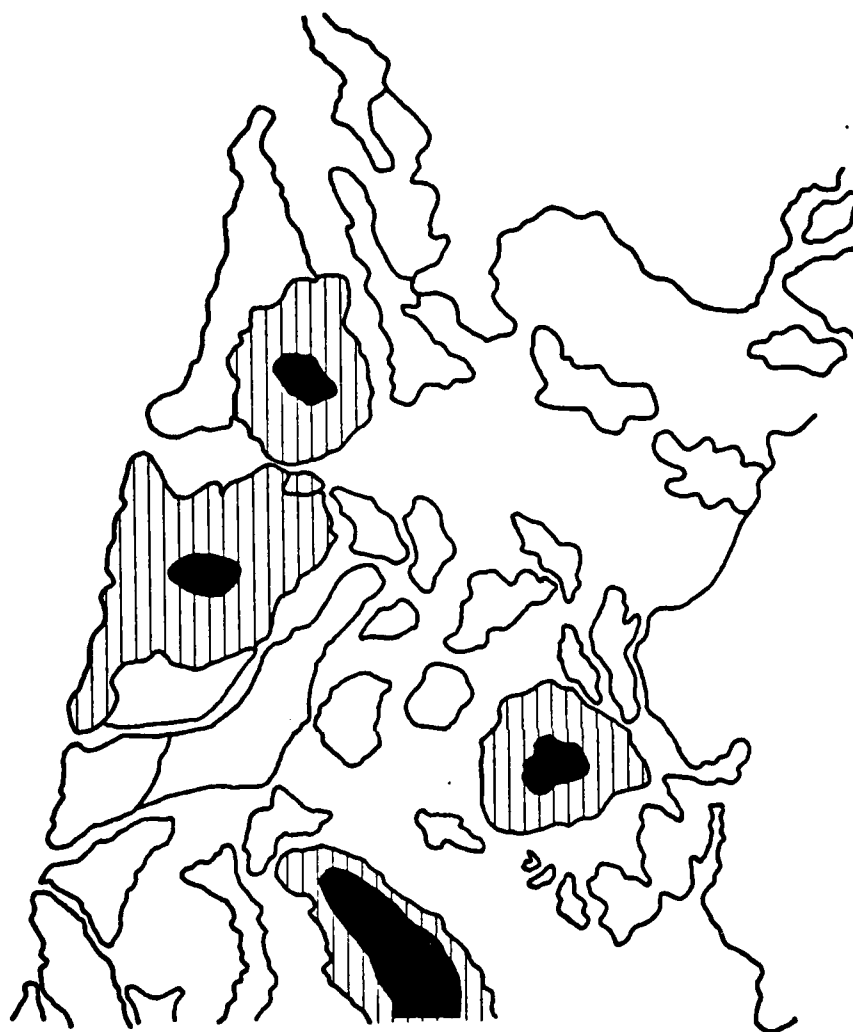


Figure 7. Aquatic relationships.

will be able to estimate the amounts, types, and locations of vegetation and habitats on the installation.

The parenthetical symbols accompanying definitions below will be used as a code for tabulating information later in *Vegetation Characteristics Description*.

Trees. Trees are woody plants with a stem that has a diameter of at least 10 cm at breast height. Personnel can map trees for an installation by examining aerial photographs and transferring to a transparent overlay plots of the following characteristics:

1. Tree Types (Figure 1).

a. Evergreen (I): defined as predominantly evergreen-coniferous forest.

b. Hardwood (II): defined as predominantly deciduous-hardwood forest.

c. Mixed (III): defined as a mixture of between 40 percent to 60 percent hardwood-coniferous.

2. Canopy Closure: measured as the percent of the canopy that is closed to direct sunlight making contact with lower strata or ground (Figure 2).

a. 100 percent to 75 percent closed canopy (A).

b. 75 percent to 50 percent closed canopy (B).

c. 50 percent to 25 percent closed canopy (C).

d. 25 percent to 10 percent closed canopy (D).

e. 10 percent to trees absent (E).

The minimum area for the characterization of canopy closure should be 1 hectare, which is approximately 2.5 acres or 100 m x 100 m. The 1 hectare minimum is used because some species need that much area to maintain viable breeding populations.

Shrubs. Shrubs are multiple-stemmed woody plants which usually remain less than 5 m tall at maturity. Mapping shrubs for an installation requires some field work when the presence of trees or the poor resolution of aerial photographs hinders visual interpretation. If field work is necessary in some areas to complete Stage I, it may be desirable to complete Stages I and II simultaneously. To reduce unnecessary field work, all information from topographic maps and aerial photographs should be recorded on the "shrub overlay" before any field work is started.

1. Shrub Types (Figure 3).

a. Evergreen (I): predominantly evergreen-coniferous shrub strata; includes desert and arctic shrubs that are not gymnosperms (conifer and their allies) but maintain their foliage to reduce their leafing time and energy budgets during the growing season.

b. Deciduous (II): predominantly a deciduous shrub strata.

c. Mixed (III): a mixture of between 40 percent to 60 percent evergreen-deciduous.

2. Crown Cover. This is an estimate of the percentage of surface area shaded by the crown of the shrub strata (Figure 4).

a. 100 percent to 75 percent (1).

b. 75 percent to 50 percent (2).

c. 50 percent to 25 percent (3).

d. 25 percent to 10 percent (4).

e. 10 percent to shrub crown cover absent (5).

The minimum area for the characterization of crown cover should be 0.25 hectare, which is approximately 0.60 acre or 50 m x 50 m.

Herbs. Herbs are soft-stemmed, nonwoody plants. Mapping the herbaceous strata for any installations requires considerably more field work than either trees or shrubs. The only information available from aerial photographs is in those areas where the tree or shrub strata are absent or reduced, and even this information is generally limited to the presence or absence of an herb strata. Again, it should be emphasized that before beginning any field work, all portions of Stage I should be as complete as possible. Much of the field work will be repetitious or can be completed simultaneously with other parameters, thus reducing the overall, labor-intensive portion of Stage I.

1. Herb Types (Figure 5).

a. Monocots (I): predominantly grasses (monocot).

b. Dicots (II): predominantly broadleaf (dicot) species.

c. Mixed (III): a mixture of between 40 percent to 60 percent monocot-dicot.

2. Ground Cover. This is an estimate of the percentage of ground surface covered or shaded by herbaceous organisms (Figure 6).

- a. 100 percent to 75 percent (A).
- b. 75 percent to 50 percent (B).
- c. 50 percent to 25 percent (C).
- d. 25 percent to 10 percent (D).
- e. 10 percent to herb strata absent (E).

The minimum area for characterization of ground cover should be 0.25 hectare, which is approximately 0.60 acre or 50 m x 50 m.

Aquatic Relationships. To determine these characteristics, aerial photographs, soil surveys, and topographic maps are necessary. By combining information from the photographs, surveys, and maps, investigators will be able to produce an overlay for aquatic relationships (Figure 7).

- 1. Upland (1): areas of well-drained soils not subject to periodic flooding.
- 2. Bottomland (2): areas subjected to periodic flooding that are at least 20 m from any moving or standing body of water.
- 3. Riparian (3): areas, whether or not they are subject to periodic flooding, that are within 20 m of a moving or standing body of water.
- 4. Marsh/Swamp (4): areas that normally maintain standing water that is not open and free flowing.
- 5. Arid/Semi-Arid (5): areas that normally receive less than 20 in. (50.8 cm) of rainfall per year.

Vegetation Characteristics Description

The following discussion tells how to prepare descriptive tables compiling more definitive data than on the overlays, and Table 1 is an outline for presenting the required data.

1. Trees.

a. Tree Species Estimate. The last step in completing Stage I for trees is to prepare a list of tree species that could inhabit the installation. The literature on the range, distribution, and habitat requirements for trees must be searched (see Appendix A). For each species whose range includes the installation, its common name, scientific name, and habitat (niche) requirements should be provided. This information should then be cross-referenced with the code listing of

Table 1
Vegetational Composite

Code			Description	Approximate Acreage	Species Present In This Habitat
Tree	Herb	Shrub	Verbal		
III	III	III	Upland hardwood forest with 75 percent to 50 percent closed canopy, deciduous shrubs with 25 percent to 10 percent crown cover, mixed herbs with 10 per- cent to absent ground cover	3250	Plants Mammals Birds Reptiles

tree types, canopy closure, and aquatic relationships. This would result in a table containing information such as that in Table 1.

b. Estimation of Acreage. With this information laid out on an overlay, it is easy to use standard planimetry to estimate the approximate amount of acreage for each sequence of tree parameters.

2. Shrubs.

a. Shrub Species Estimate. The last step in completing Stage I for shrubs is to prepare a list of shrub species that could inhabit the installation. The literature on the range, distribution, and habitat requirements for shrubs must be searched (see Appendix A). The common name, scientific name, and habitat requirements of each species whose range includes the installation should be listed. This information should then be cross-referenced with the coded listing of shrub types, etc. The results should be presented in a table containing information such as in Table 1.

b. Estimation of Acreage: see tree section above.

3. Herbs.

a. Herb Species Estimate: see shrub section.

b. Estimate of Acreage: see tree section.

c. Matting: defined as the dead plant material lying on the surface of the ground. This includes all plant material but does not include standing dead material. Matting is measured as the material's vertical thickness and should be based on the same minimal area as

described under ground cover (may require field work and can be delayed until the completion of Stage II or III). The thickness should be coded as follows:

- (1) Thick: 8 cm or more (1).
- (2) Medium: 4 to 8 cm (2).
- (3) Thin: up to 4 cm (3).
- (4) Absent: (4).

4. Algae, Fungi, Lichens, and Other Plant Species. The "other plant species" in this category are groups such as the ferns, liverworts, and mosses. Mapping this category is only slightly useful in obtaining a satisfactory overview of an installation since these plants do not play a major role in the trophic structure (energy flow) of the terrestrial ecosystem. However, the plants may be significant in an ecosystem -- rock, for example -- that is biologically and nutritionally barren. The most efficient and useful method of analyzing these plants is first to prepare a master list of the species, as was done in the "Species Estimate" sections for trees, shrubs, and herbs above. Second, the information presented in the literature on habitat requirements could be matched with the information obtained from topographic maps, aerial photographs, and the tree, shrub, and herb maps, and the listing of species assigned to the basic areas of the installation.

5. Rare, Endangered, or Threatened Plant Species. This category requires extremely definitive analysis. Any information gathered during Stage I will be useful in identifying specific problems. A list of all rare, endangered, or threatened plant species should be formulated along with a description of the habitats and a statement on their known or probable range. This list and discussion should be compared with all the information gathered to this point, and the species that have the potential to exist on the installation should be determined.

Animals

The successful completion of Stage I for animals will depend heavily on how well the vegetational portion has been completed, particularly the sections on trees, shrubs, and herbs.

At first, most animals are mapped on the basis of groups of species. Some species -- such as large and small mammals, game birds, and rare, endangered, or threatened species -- require separate mapping. Although the topographic maps and aerial photographs are of some aid, the completed vegetational maps are most helpful.

The literature on each category of animals described in this section should be consulted (see Appendix A) and a list of all species, or each group, compiled. The list should include not only those species whose known ranges include the installation, but also all those species whose ranges are reasonably close -- since, as mentioned earlier, Stage I is a compilation of floral and faunal parameters that potentially exist on the installation. Stages II and III are used to verify the presence of these organisms or habitats to document population dynamics. The example given for mammals in Table 2 is based on Fort Knox, KY, and lists 57 species. Of these 57 species, 10 are either on the edge of their ranges or close enough to require consideration in mapping.

Mammals

Mammals should be mapped in two different ways; to explain these methods the information on Fort Knox is used as an example. All mammals that are hunted and trapped (edible or fur bearers) or that are rare, endangered, or threatened should be mapped separately by species. The remainder of the mammalian species should be grouped on the basis of habitat.

Hunted, Trapped, Rare, Endangered, Threatened Species. Figure 8 is a list of such species at Fort Knox. An overlay indicating areas of suitable habitat should be completed for each species (Figures 9 and 10).

Other Mammalian Species. These species should be organized by habitat, and no mapping is necessary at this level. Each species should be cross-referenced with the various types of vegetational characteristics of the installation. This can be done by completing Table 3.

Birds

Table 2 should be completed for birds as it was for mammals. Birds should be mapped in two stages. All birds that are considered game, rare, endangered, or threatened should be mapped separately on the basis of habitat. Then remaining bird species also should be grouped on the basis of habitat. To explain this method, the information on Fort Knox will be used as an example.

Game, Rare, Endangered, and Threatened Species. Figure 11 is a list of game, rare, endangered species at Fort Knox. An overlay indicating areas of suitable habitat should be completed for each of the species. The residency of each species should be determined and indicated as follows: AY = year round resident; B = breeding range only; W = winter resident; M = migrant.

It may be relatively simple to combine species into an overlay representing several species -- for example, ducks, geese, and other waterfowl.

Table 2

Mammals (Fort Knox, Kentucky)

Common Name	Scientific Name	Habitat	Economic Status					Pop. State Potential
			Hunt	Edible	Furbearing	Pest	Pest Control	
Opossum	<u>Didelphis</u> <u>marcupialis</u>	Woodlands along streams	X	X	X	?		
Smoky Shrew	<u>Sorex</u> <u>fumeus</u>	Birch and hemlock forests with decomposing leaf litter on ground				?		May be abundant
Southeastern Shrew	<u>Sorex</u> <u>longirostris</u>	Open fields and woodlots, moist areas preferred				?		
Least Shrew	<u>Cryptotis</u> <u>parva</u>	Open grass-covered area, scattered brush, also marshes				?		
Shorttail Shrew	<u>Blarina</u> <u>brevicanuda</u>	Forests, grasslands, marsh areas; not restricted				?		Up to 25 per acre
Eastern Mole	<u>Scalopus</u> <u>aquaticus</u>	Sandy loam; lawns, golf courses, gardens, field meadows, avoid extremely dry soil			X	?		
Little Brown Bat	<u>Myotis</u> <u>lucifugus</u>	Caves, mine tunnels, hollow trees, buildings			?	X		
Mississippi Myotis	<u>Myotis</u> <u>austroriparius</u>	Caves, mine tunnels, hollow trees, buildings, culverts, bridges			?	X		

X = definitely important

? = probably or possibly important

* = ranges approximate installation

Table 2 (cont'd)

Common Name	Scientific Name	Habitat	Economic Status					Pop. State Potential
			Hunt	Edible	Furbearing	Pest	Pest Control	
Gray Myotis	<u>Myotis</u> <u>grisescens</u>	Caves				?	X	
Indiana Bat	<u>Myotis</u> <u>sodalis</u>	Caves, possibly man-made structures, hollow trees				?	X	Endangered
Small-footed Myotis	<u>Myotis</u> <u>subulatis</u>	Caves, mine tunnels, crevices in rocks, buildings, near forested areas				?	X	
Silver-haired Bat	<u>Lasionycteris</u> <u>noctivagans</u>	Forested areas, possible buildings and caves				?	X	
Eastern Pipistrel	<u>Pipistrellus</u> <u>subflavus</u>	Caves, mine tunnels, crevices in rocks, buildings, wooded areas, near water				?	X	
Big Brown Bat	<u>Eptesicus</u> <u>fuscus</u>	Caves, tunnels, crevices, hollow trees, buildings, wooded areas				?	X	
Red Bat	<u>Lasiurus</u> <u>borealis</u>	Wooded areas, roosts in trees, occasionally caves				?	X	
Hoary Bat	<u>Lasiurus</u> <u>cinereus</u>	Wooded areas				?	X	
Evening Bat	<u>Myotis</u> <u>numeralis</u>	Buildings and hollow trees				?	X	
Western Big-Eared Bat	<u>Plecotus</u> <u>townsendi</u>	Caves, mine tunnels, buildings				?	X	
Eastern Big-Eared Bat	<u>Plecotus</u> <u>rafinesquiei</u>	Caves, mine tunnels, buildings				?	X	
Raccoon	<u>Procyon</u> <u>lotor</u>	Along streams and lakes with wooded areas or cliffs nearby	X	X	X	X	X	X

Table 2 (cont'd)

Common Name	Scientific Name	Habitat	Economic Status					Pop. State Potential
			Hunt	Edible	Furbearing	Pest	Pest Control	
Longtail Weasel	<u>Mustela frenata</u>	Not restricted but near water		X	X	X		
River Otter	<u>Lutra canadensis</u>	Along streams and lakes		X				
Spotted Skunk*	<u>Spilogale putorius</u>	Brushy or sparsely wooded areas, along streams, among boulders, prairies		X	?	X		Possible rabies carrier
Striped Skunk	<u>Mephitis mephitis</u>	Semi-open country; mixed woods, brushland, and open prairies preferred within 2 miles of water		X	?	X		Possible rabies carrier
Coyote*	<u>Canis latrans</u>	Prairies, open woodlands, brush or boulder strewn areas	X		X	X		
Red Fox	<u>Vulpes vulpes</u>	Mixture of forest and open country preferred	X	X	X	X		Home range 1-2 sq mi
Gray Fox	<u>Urocyon cinereoargenteus</u>	Chaparral, open forests, rimrock country	X	X	X	X		Rare
Bobcat*	<u>Lynx rufus</u>	Swamps and forests in the east	X	X	X	X		Rare
Woodchuck	<u>Marmota monax</u>	Open woods, brushy and rocky ravines	X	?	X			
Eastern Chipmunk	<u>Tamias striatus</u>	Deciduous forests, brushy areas				?		Aesthetically pleasing
Eastern Gray Squirrel	<u>Sciurus carolinensis</u>	Hardwood forests with nut trees, river bottoms	X	X	X			Home range 2-7 acres, pop. 2-20 per acre
Eastern Fox Squirrel	<u>Sciurus niger</u>	Open hardwood woodlots in north-land, pine forests in south, both with clearing interspersed	X	X	X			Home range, pop. 0.5 to 3.0 per acre

Table 2 (cont'd)

Common Name	Scientific Name	Habitat	Economic Status				Pop. State Potential
			Hunt	Edible	Furbearing	Pest Control	
Red Squirrel*	<u>Tamiasciurus</u> <u>hudsonicus</u>	Pine and spruce or mixed hardwood forests, swamps	X	X			Aesthetically pleasing, 1-10 per acre
Southern Flying Squirrel	<u>Glaucomys</u> <u>volans</u>	Woodlots and forests of deciduous, mixed deciduous-coniferous trees					1-2 per acre
Beaver	<u>Castor</u> <u>Canadensis</u>	Streams and lakes with trees or alders on banks		X	X ?		
Eastern Harvest Mouse	<u>Reithrodontomys</u> <u>humilis</u>	Old fields, marshes, wet meadows					
Deer Mouse	<u>Peromyscus</u> <u>maniculatus</u>	Dry land habitat; forests, grasslands or mixtures					Home range, 1/2 - 3 acres 10-15 per acre
White-footed Mouse	<u>Peromyscus</u> <u>leucopus</u>	Wooded or brushy areas preferred, open areas occasionally					Home range, 1/2 - 1 1/2 acres
Cotton Mouse*	<u>Peromyscus</u> <u>gossypinus</u>	Wooded areas, along streams or bordering fields, swampland					
Golden Mouse*	<u>Ochrotomys</u> <u>nuttalli</u>	Forests, edges of canebrakes, moist thickets, honeysuckle, greenbriar, Spanish moss					
Eastern Woodrat	<u>Neotoma</u> <u>floridana</u>	Rocky cliffs; hammocks, swamps					2-3 per acre
Rice Rat	<u>Oryzomys palustris</u>	Marshy areas, grasses and sedges					
Southern Bog Lemming*	<u>Synaptomys cooperi</u>	Low damp bogs and meadows with heavy growth of vegetation			?		Home range, 1/3 acre up to 35 per acre

Table 2 (cont'd)

Common Name	Scientific Name	Habitat	Economic Status				Pop. State Potential
			Hunt	Eatble	Furbearing	Pest Control	
Meadow Vole	<u>Microtus pennsylvanicus</u>	Low moist areas or grasslands with rank growths of vegetation; near swamps, lakes, streams, occasionally in forests with little ground cover; orchards with grass undergrowth			?		Home range
Prairie Vole	<u>Microtus ochrogaster</u>	Open prairies, fence rows, railway right-of-way, old cemeteries, fairly dry places			?		
Pine Vole	<u>Microtus pinetorum</u>	Forest floor, orchards			?		
Muskrat	<u>Ondatra zibethica</u>	Marshes, edges of ponds, lakes, and streams, cattails, rushes, water lilies, open water		X	?		
Norway Rat	<u>Rattus norvegicus</u>	Buildings and rubbish pile			X		Pop. 1 per 5 or 6 people
Black (Roof) Rat	<u>Rattus rattus</u>	Buildings, rubbish, occasionally fields			X		
House Mouse	<u>Mus musculus</u>	Buildings, rubbish, occasionally fields			X		
Meadow Jumping Mouse	<u>Zapus hudsonius</u>	Prefers low meadows, but unrestricted					Scarce Home range, 1/2 - 2 acres

Table 2 (cont'd)

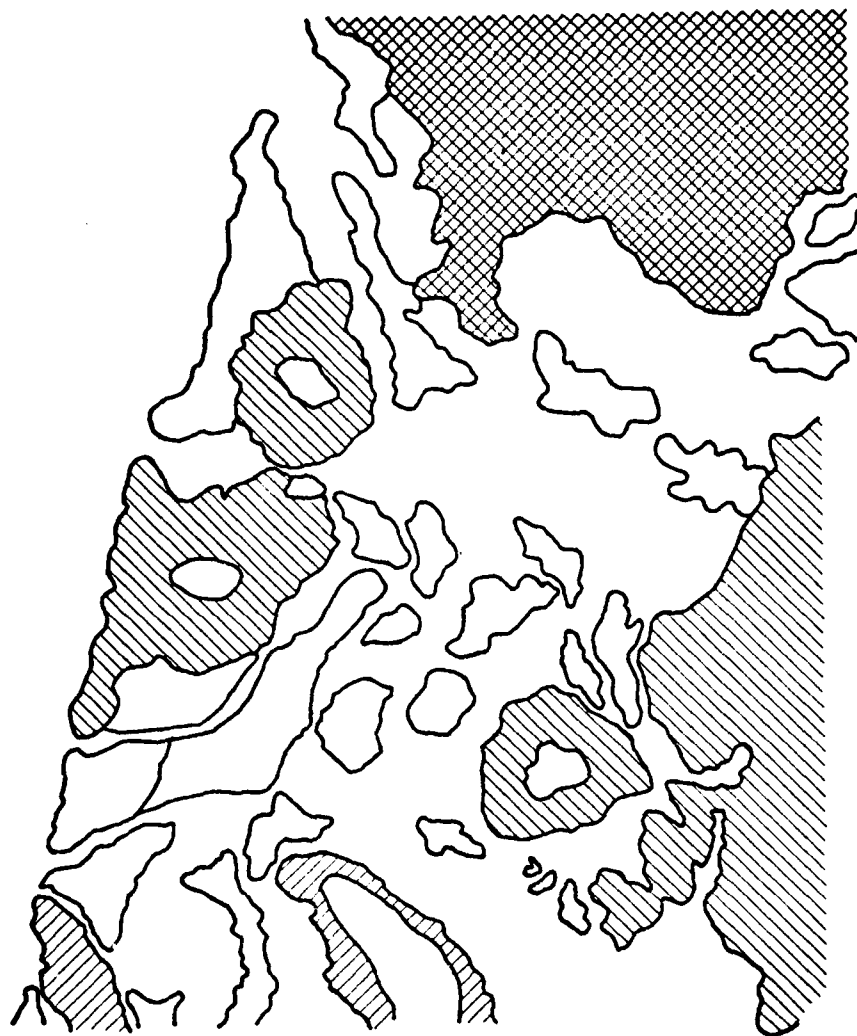
Common Name	Scientific Name	Habitat	Economic Status					Pop. State Potential
			Hunt	Edible	Furbearing	Pest	Pest Control	
Eastern Cottontail	<u>Sylvilagus floridanus</u>	Heavy brush, strips of forest with open areas, edges of swamps, weed patches	X	X	X			Home range, 3-20 acres 1 per 4 acres
Swamp Rabbit	<u>Sylvilagus aquaticus</u> *	Swamps, marshes, wet bottom-lands	X	X	X			Home range, 11-27 acres
Whitetail Deer	<u>Odocoileus virginianus</u>	Forests, swamps, open brushy areas	X	X	X			Home range, up to 1 sq mile
Masked Shrew	<u>Sorex cinereus</u> *	Moist situations; forests, open country, brushland				?		
Keen Myotis	<u>Myotis keeni</u>	Mine tunnels, caves, buildings, hollow trees, storm sewers, forested areas				?	?	

- | | |
|--------------------|---------------------------|
| 1. Opossum | 12. Woodchuck |
| 2. Raccoon | 13. Eastern Gray Squirrel |
| 3. Longtail Weasel | 14. Eastern Fox Squirrel |
| 4. Mink | 15. Red Squirrel |
| 5. River Otter | 16. Beaver |
| 6. Spotted Skunk | 17. Muskrat |
| 7. Striped Skunk | 18. Eastern Cottontail |
| 8. Coyote | 19. Swamp Rabbit |
| 9. Red Fox | 20. Whitetail Deer |
| 10. Gray Fox | 21. Indiana Bat |
| 11. Bobcat | |

Figure 8. List of critical mammal species at Fort Knox.

Table 3
Vegetational Composite With List of Mammals

Code			Description	Approximate Acreage	Species Present In This Habitat
Tree	Herb	Shrub			
11B1	114	111	Upland hardwood forest with 75 percent to 50 percent closed canopy, deciduous shrubs with 25 percent to 10 percent crown cover, mixed herbs with 10 percent to absent ground cover	3250	<p>Mammals</p> <ol style="list-style-type: none"> 1. <u>Blarina brevicauda</u> 2. <u>Myotis lucifugus</u> 3. <u>Myotis sodalis</u> 4. <u>Myotis subulatus</u> 5. <u>Lasionycteris noctivagans</u> 6. <u>Pipistrellus subflavus</u> 7. <u>Eptesicus fuscus</u> 8. <u>Lasiurus borealis</u> 9. <u>Lasiurus cinereus</u> 10. <u>Nycticeius humeralis</u> 11. <u>Lynx rufus</u> 12. <u>Tamias striatus</u> 13. <u>Sciurus carolinensis</u> 14. <u>Sciurus niger</u> 15. <u>Glaucomys volans</u> 16. <u>Peromyscus maniculatus</u> 17. <u>Peromyscus leucopus</u> 18. <u>Odocoileus virginianus</u> 19. <u>Myotis keeni</u>






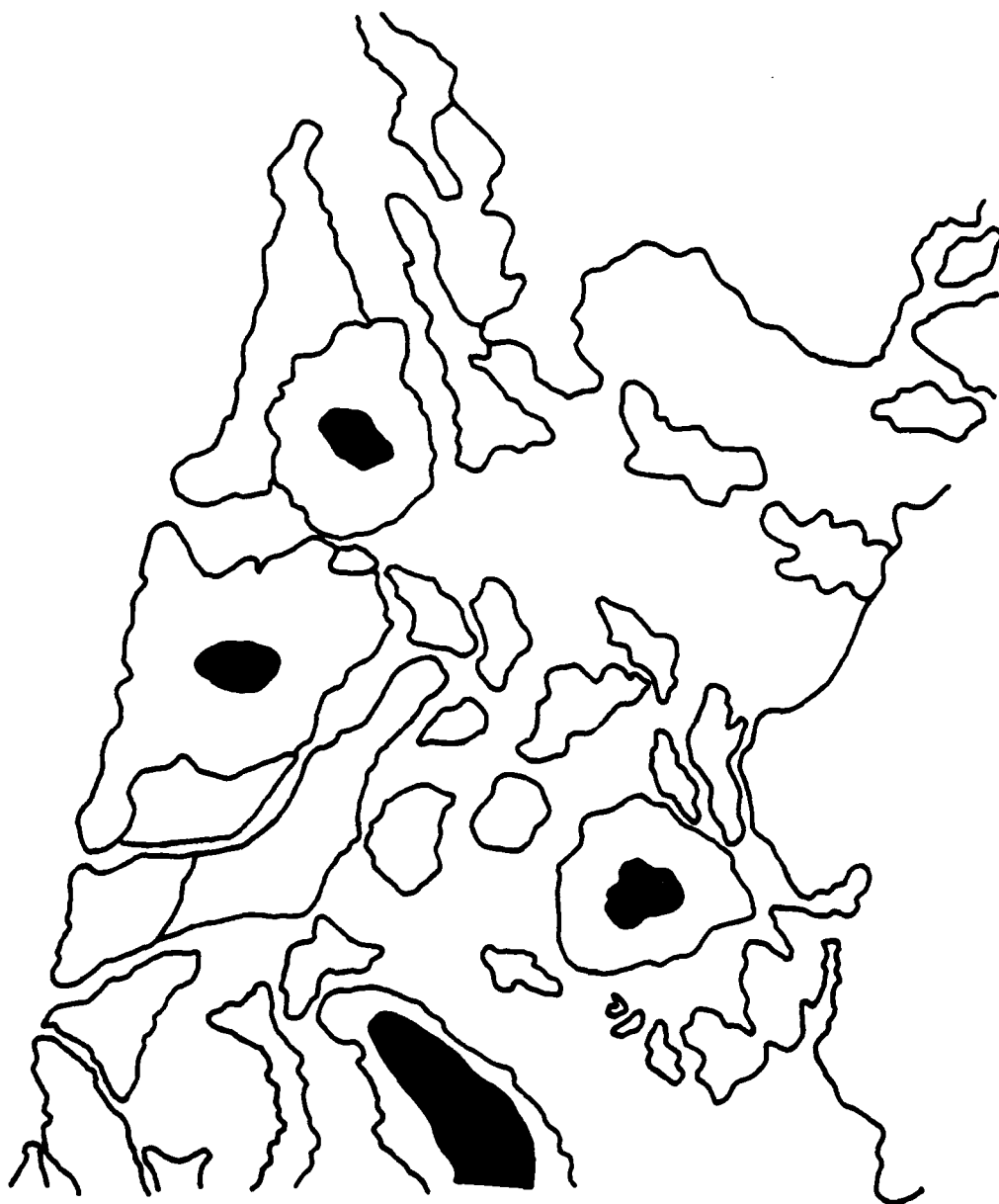
-  Eastern Fox Squirrel
-  Eastern Gray Squirrel
-  Both

Figure 9. Habitat areas -- squirrel.



 Muskrat

Figure 10. Habitat areas -- muskrat.

1. Wood Duck	AY	18. Bald Eagle	W
2. Turkey	AY	19. Peregrine Falcon	W
3. Ruffed Grouse	AY	20. Canada Goose	M
4. Bobwhite	AY	21. Blue Goose	M
5. Mourning Dove	AY	22. Snow Goose	M
6. Pileated Woodpecker	AY	23. Pintail	M
7. Common Crow	AY	24. Gadwall	M
8. Hooded Merganser	B	25. American Widgeon	M
9. American Coot	B	26. Shoveler	M
10. American Woodcock	B	27. Blue-winged Teal	M
11. Mallard	W	28. Green-winged Teal	M
12. Black Duck	W	29. Red Head	M
13. Ring-necked Duck	W	30. Canvasback	M
14. Common Goldeneye	W	31. Greater Scaup	M
15. Bufflehead	W	32. Lesser Scaup	M
16. Common Merganser	W	33. Ruddy Duck	M
17. Red-breasted Merganser	W		

Figure 11. Critical bird species at Fort Knox.

Other Birds. These species should be organized by habitat; no mapping is necessary at this stage. Each species should be cross-referenced -- as were mammals in Table 3 -- with the various types of vegetational characteristics of the installation. This can be done by first completing Table 2 for birds. In addition to the information presented in Table 2, the residency for each species should be indicated as it was with the game, rare, endangered, and threatened species.

Other Animals

All other animals (reptiles, amphibians, insects, other invertebrates) should follow the same format as outlined for mammals. Most groups in this category do not require extensive mapping or documentation (for the purpose of this report) since, except for insects, they do not contribute greatly to the trophic structure of terrestrial ecosystems. Furthermore, other groups previously dealt with are equally indicative of environmental and/or habitat conditions. Nonetheless, it should be noted that these groups are important to communities in which they reside, and if lost or impacted, could disrupt the community and trophic structure. For example, the impact of insects is important because they alone consume more vegetation than all other organisms.

3 STAGE II. VERIFICATION OF TERRESTRIAL BIOTA

The results of Stage I should yield a composite picture of the potential biota and habitat of the installation. The material gathered should be more accurate and reliable than existing information unless that information was obtained through actual field investigations.

Stage II, which is designed to verify the information gathered in Stage I, entails some field work. If Stage I indicates that a specific area is a hardwood, upland forest with a 75 to 50 percent closed canopy, a 25 to 0 percent shrub crown, an absent herb cover, and is inhabited by various animals, Stage II should verify such information. The vegetation information and the presence of large mammals, birds, some small mammals (squirrels, chipmunks, rabbits, etc.), some reptiles, and some amphibians can be verified by "cruising." Cruising requires making observations while taking a brief walk through the area. Verification of other parameters might involve a "one shot" collection of floral and faunal organisms. If such specimens are collected, it may be advisable to preserve these organisms for future reference or as voucher specimens. The results of Stage II yield a product that both verifies the types of habitat on that installation, and identifies, by habitat, the species of organisms existing on that installation. It would be easy to determine, for example, how many acres of forest edge exist, how many acres of suitable deer habitat, or how many acres of Redwinged Blackbird habitat are available.

Since most of this field work consists of "cruising" and spot checking information, it should not be necessary to visit all portions of the installation during this stage. Once several areas of each type of habitat have been checked for accuracy of those plant and animal parameters previously mapped, it can be assumed that Stage I resulted in a reasonably accurate characterization of similar habitats. The only exception to this assumption is if rare, endangered, or threatened species are discovered during the verification process, then all similar areas should be examined for the presence of such species.

Biotic parameters can be verified simultaneously for all plants and animals to reduce the effort required to complete Stage II. The following are suggested procedures for the verification process.

Species Familiarization

The individual(s) conducting the field investigation should become familiar with species that may be present on the installation. Before investigators go to the field, reference materials including items such

as Peterson Field Guide Series or Golden Guide Series should be consulted (these and other references are listed in Appendix A). Equipment necessary is:

1. Mouse traps, rolled oats, peanut butter.
2. Binoculars.
3. Various sizes of sweep nets.
4. Plastic bags (for plants and dead animals); cloth bags for live animals); jars with a preservative, either alcohol or formaldehyde (for invertebrates).
5. Pruning shears.
6. Trowel.
7. Light traps.
8. Fly paper.

Site Selection

The site to be surveyed should be chosen from the maps previously completed on potential habitat and biota. Initially, such an area should be one whose habitat type is one of the most common on the installation.

Field Survey

Boundary Verification

The habitat of the site should be recognizable, and investigators should drive along or walk the boundary of the habitat. The boundary, as it actually appears in the field, should be compared to that determined by use of topographic maps and aerial photographs in Stage I. Any significant deviations from the mapped areas should be corrected.

Survey Transect Determination

Personnel can verify biotic parameters by walking along line transects plotted through the area. Transects should be determined with the aid of a compass because no transects should cross each other. The number of transects that should be surveyed per unit area can be determined by the following methods (see Figure 12):

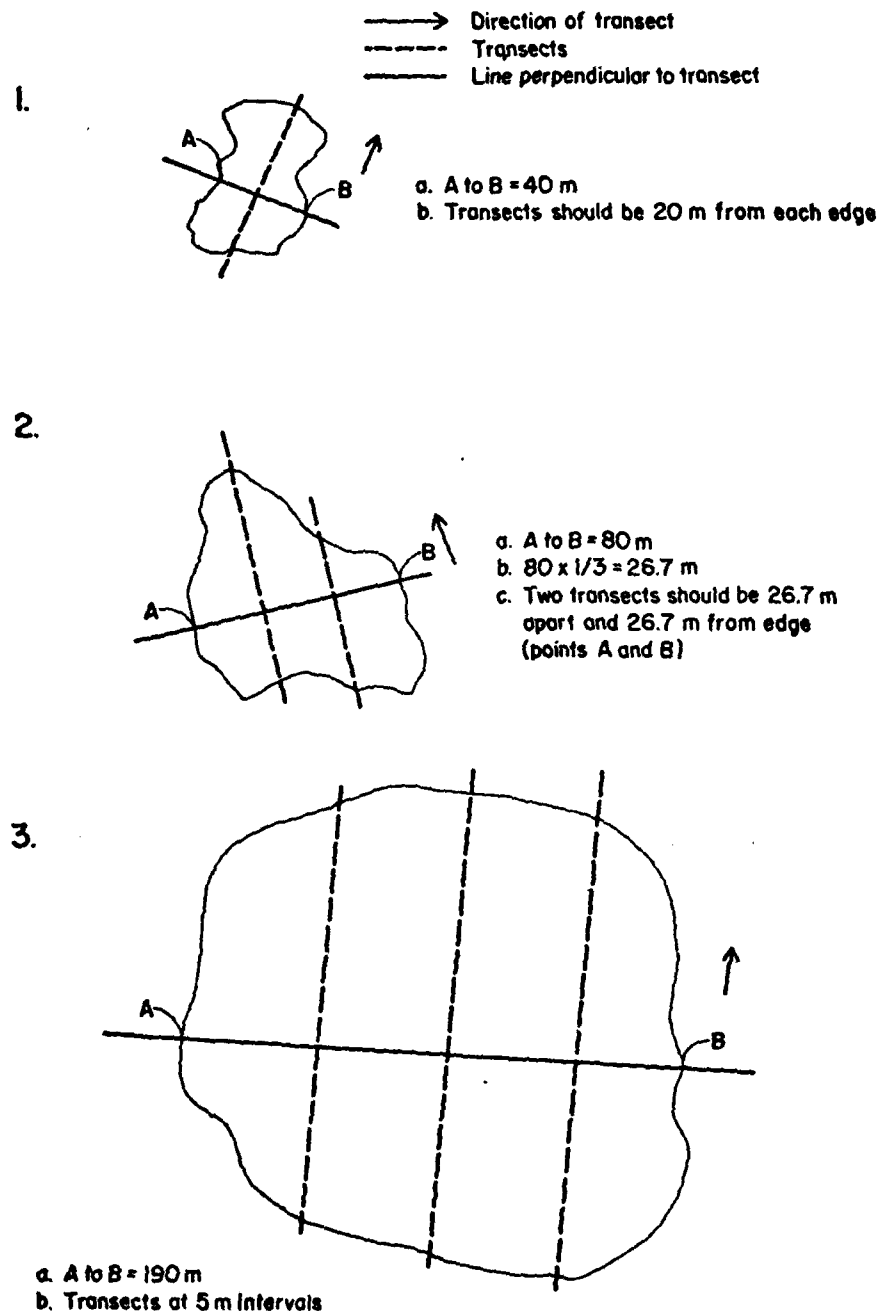


Figure 12. Survey transect determination.

1. Determine the direction of the transects. It is irrelevant whether the long or short axis is used to initiate the transects.

2. Estimate the length of the longest line that could be drawn perpendicular to the transects and still remain inside the area.

3. If the line is:

a. 50 m or less, use one transect through the center of the area (plot 1, Figure 12).

b. 50 to 100 m, use two transects at intervals of one-third the length of the line. For example, if the line is 75 m long, the first transect should be 25 m from one edge, and the second transect should be 25 m from the first and 25 from the opposite edge (plot 2, Figure 12).

c. Over 100 m, use a minimum of two transects, and transects can be set at up to 50-m intervals (plot 3, Figure 12).

Biotic and Habitat Verification

The parameters discussed below should be estimated for each transect. Upon completion of all transects, the information should be compiled and summarized. This information should then be compared with that obtained in Stage I and a more accurate characterization formulated.

1. Vegetation.

a. Trees.

(1) Tree Types: percentage of evergreen and hardwood.

(2) Canopy Closure: percentages.

(3) Aquatic Relationship: upland, bottomland, riparian, marsh/swamp, arid/semi-arid.

(4) Tree Species: record recognizable species and obtain samples of those that are unidentifiable. Samples should be taken by clipping a branch that has a terminal bud and several leaves.

b. Shrubs.

(1) Shrub Types: percentage of evergreen and deciduous.

(2) Crown Cover: percentage.

(3) Shrub Species: record recognizable species and obtain samples of those that are not. Samples should be taken by clipping a branch that has a terminal bud, several leaves, and a flower and/or fruiting body, if available.

c. Herbs.

(1) Herb Types: percentage of monocots (grasses) and dicots (broad-leaf).

(2) Ground Cover: percentage.

(3) Matting: approximate thickness.

(4) Herb Species: record recognizable species and obtain samples of those that are not. Samples should be taken by collecting the entire plant including the root system and flower or fruiting body, if available.

d. Algae, Fungi, and Lichens: record recognizable species and obtain samples of those that are not. Samples should be taken by collecting the entire plant.

e. Rare, Endangered, or Threatened Plant Species: record those species present and plot their approximate location and numbers of individuals on overlays. Do not collect samples, clippings, or disturb the plant in any way.

2. Animals.

a. Mammals.

(1) Visual Sighting Along Transect: record all species that are recognizable.

(2) Tracks.

(3) Scat (droppings).

(4) Collection: it is necessary to collect small mammals because the secretive habitats of most rodents, shrews, moles, and bats do not allow visual identification. About 25 traps per hectare (2.47 acres) should be used, and traps should be flagged and placed near the transect line so that they can be found easily. Snap traps baited with a mixture of rolled oats and peanut butter can be used for the rodents and shrews. Mist nets and mole traps should be used for bats and moles. If gophers may be present, gopher traps will be required. All traps and nets should be set overnight and the specimens collected the following morning. Mist nets should be set at dusk and recovered shortly before dawn so as not to collect birds.

b. Birds.

(1) Visual Identification.

(2) Vocal Identification.

(3) Other Signs: some birds may be identified on the basis of tracks (turkey, pheasant). Owl pellets should be looked for and be examined by teasing them apart and looking for identifiable animal remains. Some field guides can aid in identification, or the remains can be sent to the museums or specialists listed in Appendix B.

c. Reptiles and Amphibians.

(1) Visual Identification.

(2) Collection: sweep nets can be used to collect specimens.

d. Insects and Other Invertebrates.

(1) Visual Identification When Possible.

(2) Collection: sweep nets, light traps, fly paper, litter samples can be used. Rocks, logs, and other debris can be turned over.

e. Rare, Endangered, or Threatened Animal Species: these animals should not be disturbed but should be identified and their approximate locations plotted on overlays. Numbers of individuals and precise habitat should be recorded.

Specimen Collection

1. Care should be taken that all Federal, State, and local regulations are followed. Permits may be necessary for collecting some groups of organisms.

2. Identify as many specimens as possible by using guides in the literature. This identification will be useful in later surveys.

3. Submit unidentified specimens to specialists for identification. Sources of specialists are academic institutions and various museums (Appendix B).

4. Maintain a reference collection to eliminate the need of outside expertise at a later date. Most field guides include sections on methods of collection and preservation (see Appendix A).

Other Methods of Verification

1. Special trips to the field need not be made to complete most of Stage II. An investigator could gather information, for example, while traveling around the installation on other duties.

2. Groups such as the Audubon Society, Boy Scouts, and Girl Scouts may be willing to aid in this stage if given adequate guidance.

3. Academic institutions may be willing to help or conduct the study for a fee.

4. Information may be checked against that available in installation files from any previous surveys or preparation of EA or EIS.

4 STAGE III. QUANTIFICATION OF TERRESTRIAL BIOTA

Stage I provided rough estimates of the quantity of various habitats, their locations on the installation, and the potential species of plants and animals in each habitat. Stage II verified the information obtained during the first state and also presented information on relative population levels. The sampling techniques described in Stage II are designed to discern population diversity and place less emphasis on density.

Stage III involves the explicit documentation of population densities and other ecological parameters of the various organisms on the installation. Therefore, Stage III provides direct quantification of the amount of biota on the installation. This quantification is done by calculating the biomass or number of individuals present in a unit area of habitat. For example, if an installation contains 100 acres of forest edge, which in turn supports one deer per 4 acres, the result would be 25 deer inhabiting forest edge. When deer populations in other habitats are determined, the size of the deer herd can be approximated. In preparing an EA/EIS, this information would be valuable because if the amount of each type of deer habitat to be impacted is determined, then the impact on the total deer herd also can be judged.

Site Selection

An area should be chosen for survey from maps completed in Stages I and II on potential habitat and biota. It may be desirable to choose several areas of different potential to be surveyed simultaneously because examination of habitats (plants, birds, mammals, etc.) can be conducted in several areas without difficulty. Initially, such areas should be those whose habitat types are the most common on the installation. This allows maximum use of available funds and maximum benefit per unit of effort -- a critical point since field surveys are generally the most expensive item of environmental studies.

Vegetation

All vascular vegetation should be sampled in each basic type of habitat noted in Stage II. Vascular vegetation is divided into two working units: (1) woody plants greater than 2 m in height, and (2) herbaceous and woody plants less than 2 m in height.

Sample Point(s) Determination

Most vegetation sampling is conducted at points along transects, which need to be randomly determined as in Stage II. The number of sampling points required is based on the approximate acreage to be included

in the study site. It is necessary to take at least 10 (20 is preferable) samples per unit, regardless of size. The following guide should be used for determining the number of sample points:

1. 0 to 40 acres (0 to 16 hectares) = one point per acre (0.5 hectare).
2. 41 to 80 acres (16 to 32 hectares) = one point per 2 acres (1 hectare).
3. 81 to 200 acres (32 to 80 hectares) = one point per 4 acres (1.6 hectares).
4. Over 200 acres (80 hectares) = one point per 10 acres (4 hectares).

Woody Vegetation Greater Than 2 m in Height

The prism method of forest sampling is the best available because of its accuracy, ease of use, reduced field time, and reduced manpower expenditure. Although techniques for using this method are discussed in Appendix C, several points can be made here to supplement that information.

1. Transects along which sample points are to be selected should be chosen randomly.
2. Samples should be taken so that trees counted at one sampling point are not counted with those of a nearby point. This problem can be solved by using a different size (diopter) prism or by separating sample points and/or transects by a greater distance.

3. Data should be taken as in the following example:

The forest to be surveyed is approximately 63 acres in size; therefore, investigators will have to take $63 \div 2 = 32.5$ or 33 samples. The transect is selected as a random compass direction and 25 m chosen to separate sample points. Table 4 gives sample data on the number of each of 14 species of trees at the 33 separate sampling points.

4. Calculation following the guidelines in Appendix C yields the following results:

- a. 33 points, total count 141, prism factor 27.62.
- b. $141 = 4.273 \times 27.62 = 118 \text{ sq ft } (12 \text{ m}^2) \text{ of basal area per acre (0.5 hectare).}$
- c. Results should be tabulated as in Table 5.

Table 4
Trees' Basal Area

Sample Point	Species														Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	1		2							1					4
2		1					1		2			1			5
3						1					2				3
4			2	1					2						3
5					3										5
6	1					1								1	3
7		1		1					1				1		4
8	2		1			2									5
9		1			2			1							4
10										1	1	1	1		4
11				2				2	1						5
12		2					2							1	5
13	1		2			1									4
14					1						2		2		5
15									1			1		2	4
16							2			2	1				5
17	2	1	1												4
18		1	2	1											4
19			2	1	1	1									5
20							4								4
21									1		1	1		1	4
22	1	2				1									4
23		1					2				1		1		5
24				1						1				2	4
25	2				1			1							4
26		1			2		3								6
27								3		2					5
28		1													1
29			2			1		1		1			1		6
30	2				2										4
31	1		1		1			1							4
32		2								2				1	5
33			1		1		1					1			4
Totals	13	14	16	7	14	8	15	9	8	10	8	5	6	8	141

Table 5
Basal Area Results

Species	Total Count	Average Count	Basal Area/Acre (0.5 Hectare)
1	13	0.394	10.88
2	14	0.424	11.71
3	16	0.485	13.40
4	7	0.212	5.56
5	14	0.424	11.71
6	8	0.242	6.68
7	15	0.455	12.57
8	9	0.273	7.54
9	8	0.242	6.68
10	10	0.303	8.37
11	8	0.242	6.68
12	5	0.152	4.20
13	6	0.182	5.03
14	8	0.242	6.68

Vegetation Less Than 2 m in Height

A circle whose radius is 1/1000 of an acre (44.68 in. or 113.5 cm) should be plotted at each sampling point used for trees. All vegetation within this area must be identified, and an estimate of cover diameter, the percentage of cover of the plot, and the number of stems within the plot must be recorded (Table 6). The results should be tabulated in Table 7. Appendix D outlines additional methods of vegetation sampling.

Mammals

Although game species and furbearers such as deer, rabbits, and tree squirrels may be of more interest to the general public, small mammals -- primarily mice, rats, and shrews -- yield more statistically significant data. These mammals are the easiest to collect and allow for a study of short duration. Their relatively small home ranges and high densities of individuals permit such studies to be conducted on small areas and uniform habitat.

There are two generally accepted methods of studying the population densities of small mammals. One involves permanently removing the animals from the site (capture-removal) and the other does not (capture-recapture). Considerable controversy exists over which of these methods is more accurate, and over whether the advantages or disadvantages of one sufficiently outweigh those of the other.

Table 6
Vegetation Less Than 2 Meters in Height -- Raw Data

Sample Points	Species (crown diameter/cover %/number of stem)										
	1	2	3	4	5	6	7	8	9	10	11
1	9/60/4	9/20/7	8/50/3	.	.	.					
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
Totals											

Table 7
Vegetation Less Than 2 Meters in Height -- Results

Species	Cover	Frequency	Density
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
.			
.			
.			
.			
N			

Cover = average % of sample plot crown cover
Frequency = % of occurrence in sample plot
Density = average number of stems per sample plot

Capture-removal allows for quicker analysis of population densities, but in turn results in less data, loss of the animals to the population, and a slightly reduced level of accuracy. However, capture-recapture will be explained here since it can provide more information than capture-removal and does minimal damage to existing populations.

The site chosen for capture-recapture should have at least a 1-hectare study grid with a 25-m buffer area surrounding the grid in which the habitat is similar to the study grid. This will reduce the probability of immigration and emigration of small mammals. The area of the grids should be inspected for the presence of large mammals (domestic and endemic) that might disturb the study by eating the bait, eating the specimen, or otherwise reducing the accuracy of the data collected. The area should be inspected for the relative population densities of insects, particularly ants, that may remove bait, trip traps, or damage specimens. If there are many ants, alternate methods of trapping and the timing of running the traps can be implemented (see Appendix D). The following paragraphs provide additional details on using the capture-recapture method.

Equipment

1. Folding live traps per grid: 121.
2. Flags on wire per grid: 121.
3. Peanut butter and oatmeal or cracked corn.
4. Metric scales in 1-gram units.
5. Scissors or toenail clippers.
6. Rapidograph and permanent ink.
7. Data cards: 5 in. x 8 in. (Figure 13).
8. Cloth sack, sock, or stocking.
9. Bulk cotton: enough to supply nest material in traps.
10. Leather gloves: usually not necessary if handler is experienced.
11. Quart jars with alcohol or formaldehyde to preserve those few specimens that die in traps or during handling.

Clip Number _____	Recapture	Yes	No
Species _____	Data _____		
Sex _____	Weight _____		
Grid _____	Grid Coordinates _____		
Reproductive Condition _____			
Weather Conditions _____			

Figure 13. Data card.

Methods

For each habitat, a 100-m by 100-m test grid and control grid² should be used. The grid need not be square but must total 10 000 m²; see Appendix G for an example of such a grid. The grid should be set up with the flags placed at 10-m intervals, and each flag should be labeled with its particular grid coordinates (for example, A1 or B3 in the grid from Appendix G); this will allow ready identification of grid coordinates during the actual survey period. A trap should be set within a meter of each flag. Each grid should be run in the mornings to reduce the animals' exposure.

When running each grid, all information on the data card should be completed. Assign a number to the captured specimen, and clip its toes as described below so it can be identified by that number. Since animals have four toes on a paw, for this identification system each toe has the following number:

<u>Left Front Paw</u>	<u>Right Front Paw</u>
1, 2, 4, 7	10, 20, 40, 70
<u>Left Rear Paw</u>	<u>Right Rear Paw</u>
100, 200, 400, 700	1000, 2000, 4000, 7000

This, specimen number four would have only the "four" toe on the left front paw clipped; specimen number nine would have the seven and two toes clipped; specimen 563 would have the 400 and 100, 40 and 20, and two and one toes clipped.

Toes should be clipped cleanly at the base; this should be done consistently to preclude misidentification at a later date due to natural injury. Furthermore, even though an animal has been collected previously, all information should be recorded. This will help verify identification as to species and sex, and will produce data on growth rates and changes in reproductive condition. After the animal's toes are clipped and all pertinent data are recorded, the animal can be released.

Data Management

Cards should be filled out for each individual for each time it is captured. Cards should be maintained by species and by number (toe clip number) within each species.

Analysis of Data

Population Density in Number of Each Species per Hectare (10 000 m²).
A table similar to Table 8 should be formulated for each species on each grid. Once the estimated population has leveled off (at 145 in Table 8, for example), the results tabulated after this point should be averaged. Since the grid size is 1 hectare, the results will be in individuals per hectare.

Biomass per Hectare for a Species. The weight of all individuals of each species for each grid should be averaged.

This average weight should then be multiplied by the estimated population figure determined previously. For example, the population density in Table 8 was 148.9 individuals per hectare. If the average weight was 26.8 g, then $148.9 \times 26.8 = 3990.52$ g/hectare.

Home Range Size. This portion of the analysis is based on only those individuals that were recaptured. A card showing the grid coordinates should be produced for each individual, with all points marked where the individual was recaptured. In Appendix G, for instance, three recapture points are indicated for specimen 32, three for specimen 81, and so on.

Table 8
The Schnabel Method of Estimating Populations*

P	A	B	Marked	(A)x(B)	(A)x(B)	Recap-	C	(A)x(B)
Period	Number	Number	Animals		Sum	tures	Sum of	(C)
(date)	Trapped	Marked	in Areas				Recap-	Estimated
							tures	Population
1	4	4	--	00	0	--	--	--
2	4	4	4	16	16	0	0	--
3	2	2	3	16	32	0	--	--
4	6	6	10	60	92	0	--	--
5	10	7	16	160	252	3	3	--
6	4	4	23	92	344	0	3	--
7	8	6	27	216	560	2	5	--
8	4	2	33	132	692	2	7	--
9	5	4	35	175	867	1	8	--
10	7	6	39	273	1140	1	9	--
11	7	6	45	315	1455	1	10	145
12	9	7	51	459	1914	2	12	159
13	6	3	58	348	2262	3	15	150
14	10	6	61	610	2872	4	19	151
15	8	5	67	536	3408	3	22	154
16	6	1	72	432	3480	5	27	143
17	4	2	73	292	4132	2	29	142
18	12	7	75	900	5032	5	34	148
19	8	4	82	656	5688	4	38	149

* Table B-8, "The Schnabel Method of Estimating Populations," p 718 in Ecology and Field Biology, Second Edition by Robert Leo Smith. Copyright © 1966, 1974 by Robert Leo Smith. Reprinted by permission of Harper & Row, Publishers, Inc.

To determine the home range of each individual, the areas should be circled -- as in Appendix G -- by using the median between two grid coordinates as the average distance an animal would travel toward the next station. The area within the enclosed area is measured using planimetry or the quadrat method, for example. Then average home range for every species is determined by adding the area of home range for individuals of the species and dividing that total by the number of individuals. Care must be taken that the home ranges for the sexes are determined separately since males usually have a significantly larger home range.

Breeding Condition. The number of pregnant females, parous females, lactating females, nonreproductive females, scrotal males, and nonscrotal males of each species for each grid should be determined along with sex ratios.

Results

1. The information for each of the four points discussed in *Analysis of Data* should be recorded and organized so that it is easily retrievable -- whether by card file or computerized system.
2. Basic habitats on the installation should be compared, taking into account the four points treated under *Analysis of Data*. These comparisons are to produce concise, written evaluations of the habitats -- evaluations that should be readily available for use by those making decisions on the environmental impact of U.S. Government actions.

Birds

Birds, being both highly mobile and highly territorial, are very responsive to habitat changes. The major problem in studying bird populations, is the identification of species. Studies on birds must usually be conducted without handling the specimens, which must be identified from a distance by sight or sound. The expertise needed to do this is extensive, and a considerable amount of previous field experience is required, usually several years or more. A second problem is the timing of the survey. The survey must be conducted during the breeding season, when territories are defended. Population estimates are most feasible at this time because birds are both quite vocal -- and thus easily located and identified by their calls -- and active, making visual identification easier than at other times. The last problem is that sites must be relatively large (10 to 25 hectares) in order to obtain significant amounts of data.

Two techniques -- actually variations on one method -- are commonly used for studying bird populations. The more accurate technique involves using mist nets to trap birds. The mist nets are set up within the study area, run every mid-morning, and not reset until late evening (after dark) so the birds will not be held in the nets overnight. Birds

removed from the nets are identified and banded with a series of variously colored leg bands so that the individuals can be positively identified in the field with the aid of binoculars. Paint is sometimes put on the feathers instead of, or in addition to banding.

How can leg banding aid the accuracy of the data? If, for instance, each individual could be identified in the example described in Appendix H, a number of questions could be answered. Were the individual Cardinals, Blue Jays, and Carolina Wrens recorded near the periphery of their territories residents? Was the transient Blue Jay the male from one of the territories? Were some of the transient Redwinged Blackbirds and Grackles actually nonbreeding residents? Such information clearly could add to the data's specificity.

Trapping, collecting, or any other handling of migratory birds requires both State and Federal permits. It should be pointed out that these permits are usually very difficult to obtain, although this difficulty may be lessened because this study is essential in producing EA and EIS, and because a Governmental agency is conducting the study. Banding is not absolutely necessary, however; and the rest of this discussion deals with the technique that does not require permits and does not include banding the birds or any other handling procedures.

This technique requires sites that are a minimum of 10 hectares (24.7 acres). The maximum size the grids could be is 20 hectares (approximately 50 acres) in forested areas, and 30 hectares (approximately 75 acres) in open fields when only one person will be conducting the observations.

Sites may be flagged at even intervals along the periphery of the grid. Colored flagging should be used so that the observer can determine a specific location on the grid at a glance. The interior of the grids should be similarly flagged. A scale drawing of each grid should be made (Figure 14) with the flagging, compass direction, and other major features -- such as roads, trails, streams, and topography -- properly placed. Copies of this map should be made so that one can be used for each period of field observation and one can be used to compile observations on each species separately at the end of the study.

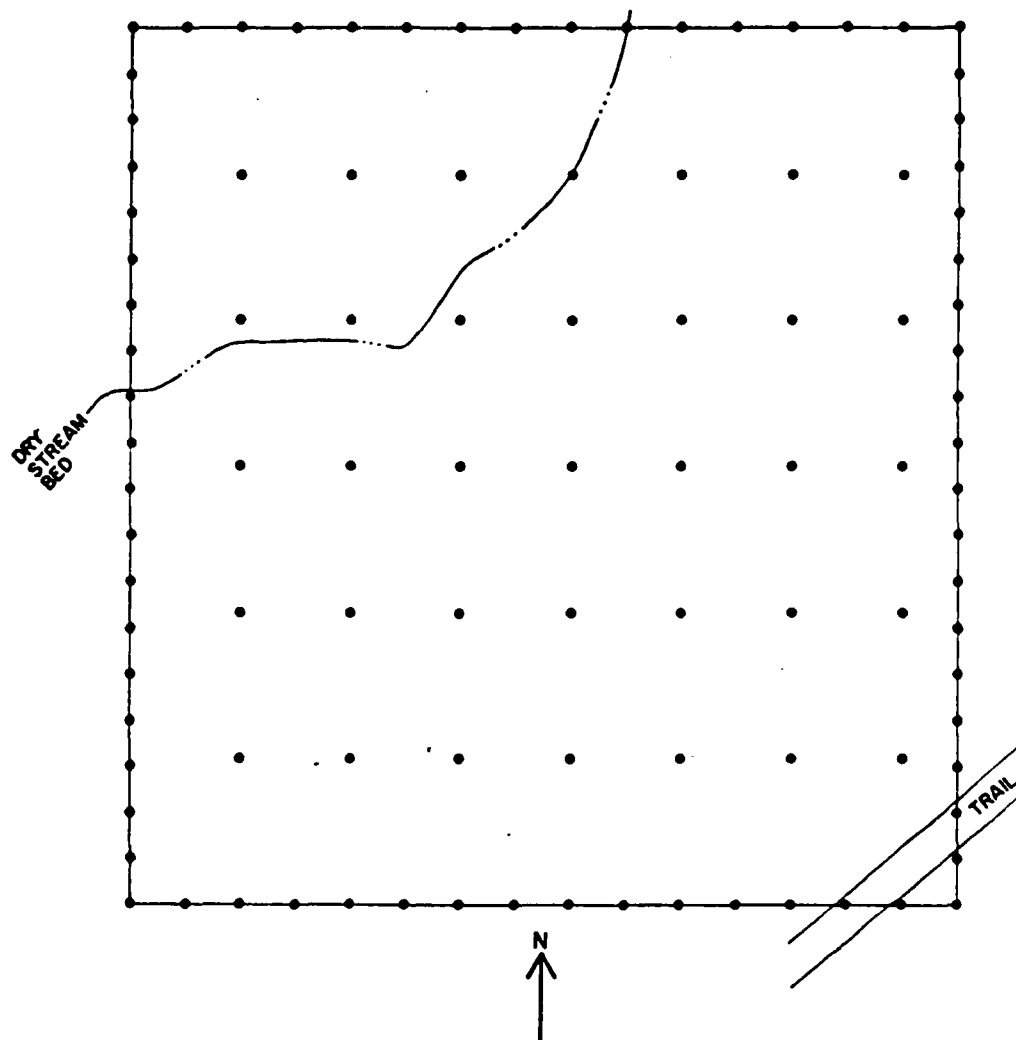
The field observations should ideally be conducted during five or six survey periods of 5 days each. For the central United States the intervals are as follows:

Number of
Survey Periods

Month

1
1
2 or 3
1

late April
mid May
June
mid July



Grid:
 Date:
 Weather:
 Time: In Out
 Total Hours:

Figure 14. Grid for field observations.

Studies in the southern part of the United States should be conducted about a week earlier than this guide suggests, and in the northern part about a week later than the guide suggests. This estimated variation probably would be sufficient, although the timing should be more accurately determined before beginning the field expedition by reviewing the literature on breeding activity in that portion of the United States. Each survey period should include a minimum of five repetitions of observations per grid, although 10 repetitions is preferable.

During each period all sites should be surveyed. The best time for surveys is in the early morning from daybreak until about 4 hours later; this is when most species are active and defending their territories. A secondary observation period exists for approximately 4 hours before nightfall. Birds are less active during this period than during the early morning, but they are active enough so that data can be collected. Since all areas cannot be surveyed simultaneously, it is best to alternate by studying one grid in the morning and another grid in the late afternoon during one day and then reversing observation periods the next day.

Day-to-day field observations should be conducted using the following guidelines. Each day's observations should be recorded on the map of the grid like that in Appendix H. The time of the observations and the total hours should be recorded along with the weather conditions. During the observations, the grids should be traversed at 100-ft (30-m) intervals, and the following information on each bird seen should be recorded on the map:

1. Species.
2. Sex.
3. Age: adult or young.
4. Behavior: feeding, roosting, flying, vocalizing, territorial dispute, etc.
5. If individual is moving, both direction and distance of flight should be recorded.
6. Active nests should be recorded.
7. All locations plotted on the map should be recorded as precisely as possible.

If time permits during the course of the field observations, investigators should try to force male birds off their territory. This can be done by walking towards the bird until it takes flight and finally doubles back. The point at which it doubles back is generally assumed to represent the border of its territory.

Upon completion of all survey periods, a composite map of each different species should be made. By examining the distribution of observation points, it should then be determined if individuals were maintaining a defended territory on the grid, or if they were unmated individuals or transients. The number of individuals of each species then can be determined by examining the number of mated pairs, number of territories being defended, or number of active nests. Appendix H describes how field observations on birds should be recorded and analyzed.

5 CONCLUSIONS AND RECOMMENDATIONS

The guidelines in this document will enable installations to compile and maintain information on terrestrial biota -- information needed to perform environmental assessments/environmental impact analyses. Since technician-level personnel at the installation, rather than consultants, can collect data over a period of time, the procedures are economical, and in addition provide detailed information on terrestrial ecosystems. Similar guidelines should be prepared for aquatic ecosystems and other specific ecological topics.

APPENDIX A:

SELECTED LITERATURE REFERENCES

This appendix contains approximately 1300 literature citations.

APPENDIX A CONTENTS

	<u>Page</u>
1. ECOLOGICAL SURVEY TECHNIQUES.....	56
2. NORTH AMERICA.....	67
General.....	67
Mammals.....	68
Birds.....	70
Reptiles and Amphibians.....	74
Fish.....	77
Insects.....	79
Other Invertebrates.....	85
Plants.....	87
3. BIOTA OF THE UNITED STATES.....	97
Alabama.....	97
Alaska.....	97
Arizona.....	99
Arkansas.....	100
California.....	100
Colorado.....	103
Connecticut.....	104
Delaware.....	105
Florida.....	105
Georgia.....	107
Hawaii.....	108
Idaho.....	108
Illinois.....	109
Indiana.....	112
Iowa.....	113
Kansas.....	114
Kentucky.....	115
Louisiana.....	116
Maine.....	117
Maryland.....	117
Massachusetts.....	118
Michigan.....	119
Minnesota.....	120
Mississippi.....	121
Missouri.....	122
Montana.....	123

APPENDIX A CONTENTS (Cont'd)

	<u>Page</u>
Nebraska.....	123
Nevada.....	123
New Hampshire.....	124
New Jersey.....	124
New Mexico.....	125
New York.....	126
North Carolina.....	127
North Dakota.....	128
Ohio.....	129
Oklahoma.....	130
Oregon.....	130
Pennsylvania.....	131
Rhode Island.....	132
South Carolina.....	132
South Dakota.....	132
Tennessee.....	133
Texas.....	134
Utah.....	136
Vermont.....	137
Virginia.....	137
Washington.....	138
West Virginia.....	138
Wisconsin.....	139
Wyoming.....	140
4. NON-U.S. BIOTA.....	142

1. Ecological Survey Techniques

- Adams, L., "Confidence Limits From the Petersen or Lincoln Index in Animal Population Studies," J. Wildlife Management, Vol 15 (1951), pp 13-19.
- Adams, Lowell W. and A. D. Geis, eds., Ecological Evaluation of Wildlife Populations and Habitats. Affected by Highway Development: Phase I," (U.S. Department of Transportation, Federal Highway Administration, Offices of Research and Development, 1978).
- Anderson, D. R., J. L. Laake, B. R. Crain, and K. P. Burnham, Guidelines for Line Transect Sampling of Biological Populations (Utah State University, Utah Cooperative Wildlife Research Unit, 1976).
- Anderson, R. M., "Methods of Collecting and Preserving Vertebrate Animals," Nat. Museum Can. Bull. (1948), p 69.
- Andrewartha, H. G., An Introduction to the Study of Animal Populations, 2nd ed. (University of Chicago Press, 1970).
- Andrews, W. A., A Guide to the Study of Freshwater Ecology, (Prentice-Hall, 1972).
- Andrews, W. A., A Guide to the Study of Soil Ecology (Prentice-Hall, 1972).
- Atlantic Waterfowl Council, Techniques Handbook of the Waterfowl Habitat Development and Management Committee (Atlantic Flyway Council, 1972).
- Balgh, M. H., L. C. Stoddart, and D. F. Balgh, "A Simple Technique for Analyzing Bird Transect Counts," Auk, Vol 88 (1977), pp 606-607.
- Bauer, H. L., "The Statistical Analysis of Chaparral and Other Plant Communities by Means of Transect Samples," Ecology, Vol 24 (1943), pp 45-60.
- Becker, D. A. and J. J. Crockett, "Evaluation of Sampling Techniques on Tall-Grass Prairie," J. Range Management, Vol 26 (1973), pp 61-65.
- Beers, T. W., and C. I. Miller, Point Sampling: Research Results Theory and Application, Res. Bull. No. 786. (Purdue Univ. Agri. Exp. Sta., 1964).
- Bell, John F., and Lucien B. Alexander, Application of the Variable Plot Method of Sampling Forest Stands, Research Note No. 30 (Oregon State Board of Forestry, 1957).
- Benson, D. A., Use of Aerial Surveys by the Canadian Wildlife Service, Occasional Papers No. 3, (Canadian Wildlife Service, 1962).

- Black, C. A., ed. Methods of Soil Analysis, Part 2, (Amer. Soc. Agron., Inc., 1965).
- Black, A. L., and J. R. Wright. "Nitrogen and Phosphorus Availability in a Fertilized Rangeland Ecosystem of the Northern Great Plains," J. Range Manage., Vol 25 (1972), pp 456-460.
- Braun-Blanquet, J. Pflanzensoziologie: Grundzuge der Vegetationskunde, 2nd ed. (Vienna: Springer, 1951).
- Braun-Blanquet, J., Plant Sociology (McGraw-Hill, 1932).
- Brown, C. A., Palynological Techniques (published by author, 1180 Stanford Ave., Baton Rouge 8, La., 1960).
- Burger, George V., Practical Wildlife Management, 2d ed., (Winchester Press, 1975).
- Cagle, F. R., "A System of Marking Turtles for Future Identification," Copeia (1939), pp 170-173.
- Cain, S. A., and G. M. Deo. Castro., Manual of Vegetation Analysis (Harper and Row, 1959).
- Canfield, R. H., "Application of the Line Interception Method in Sampling Range Vegetation," Jour. Forest, Vol 39 (1941), pp 388-394.
- Carlander, K. D., "The Standing Crop of Fish in Lakes", Journal Fisheries Resources Board of Canada, Vol 12, No. 4 (1955), pp 543-570.
- Clark, D. R., Jr., "Branding as a Marking Technique for Amphibians and Reptiles," Copeia (1968), pp 148-151.
- Clark, P., and F. Evans, "Distance to Nearest Neighbor as a Measure of Spatial Relationships in Populations," Ecology, Vol 35 (1954), pp 445-453.
- Clark, W. J. and W. F. Sigler, "Method of Concentrating Phytoplankton Samples Using Membrane Filters," Limnol. Oceanog., Vol 8 (1963), pp 127-129.
- Cochran, W. W. and R. D. Lord, Jr., "A Radio-Tracking System for Wild Animals," J. Wildlife Management, Vol 27 (1963), pp 9-24.
- Cooper, G. P., and Karl F. Lagler, "The Measurement of Fish Population Size," Transcripts of 21st North American Wildlife Conference (Wildlife Management Institute, 1956).
- Cottam, G., and J. T. Curtis, "The Use of Distance Measures in Phytosociological Sampling," Ecology, Vol 37 (1956), pp 451-460.

- Croon, G. W., D. R. McCullough, C. E. Olsen, Jr., and L. M. Queal, "Infrared Scanning Techniques for Big-Game Censusing", Journal of Wildlife Management, Vol 32, No. 4 (1968), pp 751-759.
- Curtis, J. T. and G. Cottam, Plant Ecology Workbook (Burgess Publ. Co., 1962).
- Davis, D. E., "A Chart for Estimation of Life Expectancy," J. Wildlife Management, Vol 24 (1960), pp 344-348.
- Davis, David E., "Estimating the Numbers of Game Populations," Wildlife Investigational Techniques, 2nd ed. (The Wildlife Society, 1963), pp 89-118.
- Davis, D. E. and F. B. Golley, Principles in Mammalogy (Reinhold, 1963).
- Dozier, H. L., "Estimating Muskrat Populations by House Counts," Transactions of the 13th North American Wildlife Conference (Wildlife Management Institute, 1948), pp 372-389.
- Duff, Donald A. and James L. Cooper, Techniques for Conducting Stream Habitat Surveys on National Resource Land, Technical Note 283 (U.S. Department of the Interior, Bureau of Land Management, 1976).
- Ellis, R. J., "Tracking Raccoons by Radio," J. Wildlife Management, Vol 28 (1964), pp 363-368.
- Emlen, J. T., "Estimating Breeding Bird Densities From Transect Counts," Auk, Vol 94 (1977), pp 455-468.
- Emlen, J. T., "Population Densities of Birds Derived from Transect Counts," Auk Vol 88 (1971), pp 323-342.
- Emlen, J. T., R. Hine, W. A. Fuller, and P. Alfonso, "Dropping Boards for Population Studies of Small Mammals," J. Wildlife Management, Vol 21 (1957), pp 300-414.
- Enemar, A., "Bird Species Densities Derived From Study Area Investigations and Land Transects," Bull. Ecol. Res., Comm. No. 9 (1970).
- Enemar, A., "On the Determination of the Size and Composition of a Passerine Bird Population During the Breeding Season", Vår Fågelvärld, Supplement 2, (1959), pp 1-114.
- Enemar, A. and B. Sjostrand. "The Strip Survey as a Complement to Study Area Investigations in Bird Census Work," Vår Fågelvärld, Vol 26 (1967), pp 111-130.

- Erdtmann, G., An Introduction to Pollen Analysis (Ronald, 1954).
- Evans, W. A. and F. B. Johnston, Fish Migration and Fish Passage - A Practical Guide to Solving Fish Passage Problems (U.S. Department of Agriculture, Forest Service, Region 5, 1974).
- Faegri, K., and J. Iverson, Textbook of Pollen Analysis, 2d ed (Hafner, 1964).
- Felix, C. F., "An Introduction to Palynology," in H. N. Andrews, Studies in Paleobotany (Wiley, 1961).
- Flood, Bettina S., Mary E. Sangster, Rollin D. Sparrowe, and Thomas S. Baskett, A Handbook for Habitat Evaluation Procedures (Resource Publication 132, U.S. Department of the Interior, 1977).
- Freese, F., Elementary Forest Sampling, Agricultural Handbook No. 232, U.S. Department of Agriculture, Forest Service, 1962).
- Fretts, H. C., "An Approach to Dendrochronology--Screening by Means of Multiple Regression Techniques," J. Geophys. Res., Vol 67 (1962), pp 1413-1420.
- Fretts, H. C., "Multiple Regression Analysis of Radial Growth in Individual Trees," Forest Sci., Vol 6 (1960), pp 334-349.
- Giles, R. H., Jr., Wildlife Management Techniques, (The Wildl. Soc., 1969).
- Godfrey, G. K., "Tracing Field Voles (Microtus agrestis) With a Geiger-Muller Counter," Ecology, Vol 35 (1954), pp 5-10.
- Goran, W. D. and R. E. Riggins, Graphic Materials to Support Biophysical Quantitative Environmental Impact Analysis--Sources of Existing Material (U.S. Army Construction Eng. Res. Lab., 1978), Technical Report N-68/ADA069097.
- Graham, W. J. and H. W. Ambrose, III, "A Technique for Continuously Locating Small Mammals in Field Enclosures," J. Mammal., Vol 48 (1967), pp 639-642.
- Greig-Smith, P., Quantitative Plant Ecology, 2nd ed. (Academic., 1964).
- Grodzinski, W., Z. Pucek, and L. Ryszkowski, "Estimation of Rodent Numbers by Means of Prebaiting and Intensive Removal," Acta Theriol., Vol 11 (1966), pp 297-314.
- Grosenbaugh, L. R., "Plotless Timber Estimates--New, Fast, Easy," J. Forestry, Vol 50 (1952), pp 32-37.

- Grosenbaugh, L. R., "Point-Sampling and Line-Sampling: Probability Theory, Geometric Implications, Synthesis," Southern Forest Expt. Sta. Occ. Paper 160 (U.S. Forest Serv., 1958).
- Gulland, J. A., Manual of Sampling and Statistical Methods for Fisheries Biology: Part I, Sampling Methods, FAO Manuals in Fisheries Science No. 3 (The Whitefriars Press, Ltd., London and Tonbridge, England, and UNIPUB, Inc., New York, New York, 1966).
- Hartman, R. T., Studies of Plankton Centrifuge Efficiency, Ecology, Vol 39 (1958), pp 374-376.
- Hayne, D. W., "An Examination of the Strip Census Method for Estimating Animal Populations," J. Wildlife Management, Vol 13 (1949), pp 145-157.
- Hayne, D. W., "Two Methods for Estimating Populations of Mammals From Trapping Records," J. Mammal., Vol 30 (1949), pp 399-411.
- Hesse, P. R., A Textbook of Soil Chemical Analysis (Chemical Publ. Co., Inc., 1971).
- Holme, N. A. and A. D. McIntyre, Methods for the Study of Marine Benthos, IPB Handbook No. 16 (Oxford: Blackwell, 1971).
- Hyder, D. N. and F. A. Sneva, "Bitterlich's Plotless Method for Sampling Basal Ground Cover of Bunch Grasses," J. Range Management, Vol 13 (1960), pp 6-9.
- Jackson, R. M. and F. Raw, Life in the Soil (St. Martin, 1966).
- Järvinen, O., "Estimating Relative Densities of Breeding Birds by the Line Transect Method; II. Comparison Between Two Methods," Ornis Scandinavica, Vol 7 (1976), pp 43-48.
- Järvinen, O. and R. Väisänen, "Estimating Relative Densities of Breeding Birds by the Line Transect Method," Oikos, Vol 26 (1975).
- Jolly, G. M., "Explicit Estimates from Capture-Recapture Data With Both Death and Immigration--Stochastic Model," Biometrika, Vol 52 (1965), pp 225-247.
- Kaye, S. V., "Gold-198 Wires Used to Study Movements of Small Mammals," Science, Vol 13 (1960), p 824.
- Kershaw, K. A., Quantative and Dynamic Ecology (London: Edward Arnold, 1964).

Kienholz, R., Forests and Forestry in Connecticut, Ext. Serv. No. 62-18 (The Univ. of Conn. Coll. of Agric., 1963).

Knudsen, J., Biological Techniques (Harper & Row, 1966).

Kornman, W. M., Fish and Wildlife Management Manual for Military Lands, Master of Science Thesis (Louisiana State University, School of Forestry and Wildlife Management, Baton Rouge, Louisiana,

LaGarde, Victor E., Anthony M. B. Rekas, Paul D. Lazarine, and Jack M. Stoll, Selected Legally Protected Animals: Report 1, Inventory for Use by United States Army Installations and Major Activities in the Continental United States, Technical Report M-75-2 (U.S. Army, Office, Chief of Engineers, June 1975).

Lagler, Karl F., "Capture, Sampling, and Examination of Fishes", Methods of Assessment of Fish Production in Fresh Waters (Birkenhead, England: Wilmer Brothers Ltd., 1968), pp 7-45.

Lammers, Roberta, "Sampling Insects With a Wetland Emergence Trap: Design and Evaluations of the Trap With Preliminary Results," Amer. Midl. Natur., Vol 97, No. 2 (1977), pp 381-389.

Leedy, D. L., "Aerial Photography, Their Interpretation and Suggested Uses in Wildlife Management," Journal of Wildlife Management, Vol 12, No. 2 (1948).

Lewis, James C., "Wildlife Census Methods: A Resume," Proceedings of the Annual Wildlife Disease Association Conference, Journal of Wildlife Diseases, Vol 6, No. 4, (1970), pp 356-364.

Lind, O. T., Handbook of Common Methods in Limnology (C. V. Mosby Co., 1974).

Long, G. A., P. S. Poissonet, J. A. Poissonet, Ph. M. Daget, and M. P. Godron, "Improved Needle Point Frame for Exact Line Transects," J. Range Management, Vol 25 (1972), p 228.

Lord, R. D., Jr., "The Lens as an Indicator of Age in Cottontail Rabbits," J. Wildlife Management, Vol 23 (1959), pp 358-360.

Lowe-McConnell, R. H., "Identification of Freshwater Fishes," Methods of Assessment of Fish Production in Fresh Waters (Birkenhead, England: Wilmer Brothers Ltd., 1968), pp 46-47.

Lund, J. W. G. and J. F. Talling, "Botanical Limnological Methods With Special Reference to Algae," Botan. Rev., Vol 23 (1957), pp 489-583.

Mackay, R. F., Bio-medical Telemetry (Wiley, 1970).

- MacLulich, D. A., "New Techniques of Animal Census, With Examples," J. Mammal., Vol 32 (1951), pp 18-328.
- Madsen, R. M., Age Determination of Wildlife, A Bibliography, Biblio. No. 2 (U.S. Department of the Interior, Dept. Library, 1967).
- Marten, G. C., "A Regression Method for Mark-Recapture Estimate of Population Size With Unequal Catchability," Ecology, Vol 51 (1970), pp 257-312.
- McAtee, W. L., Wildfowl Food Plants (Collegiate Press, Inc., 1939).
- McNabb, C. D., "Enumeration of Fresh Water Phytoplankton Concentrated on the Membrane Filter, Limnol. Oceanog., Vol 5 (1960), pp 57-61.
- Moen, A. N., Wildlife Ecology. (W. H. Freeman & Co., 1973).
- Morris, R. F., "Sampling Insect Populations," Annu. Rev. Entomol., Vol 5 (1960), pp 243-264.
- Morse, M. A., "Technique for Reducing Man-Power in Deer Drive Census," Journal of Wildlife Management, Vol 7, No. 2 (1943), pp 217-220.
- Mosby, Henry S., ed., Wildlife Investigational Techniques, 2d ed. (The Wildlife Society, 1963).
- Needham, J. G., Culture Methods for Invertebrate Animals (Dover, 1937).
- Neff, D. J., "The Pellet-Group Count Technique for Big Game Trend, ' Census, and Distribution: A Review," Journal of Wildlife Management, Vol 32, No. 3 (1968), pp 597-614.
- Neville, A. C., "Daily Growth Layers for Determining the Age of Grass-hopper Populations," Oikos, Vol 14 (1963), pp 1-8.
- New, J. G., "Additional Uses of Dyes for Studying the Movements of Small Mammals," J. Wildlife Management, Vol 23 (1959), pp 348-351.
- New, J. G., "Dyes for Studying the Movements of Small Mammals," J. Mammal., Vol 39 (1958), pp 416-429.
- Oman, P. W. and A. D. Cushman, Collection and Preservation of Insects, Misc. Publ. 60 (U.S. Dept. of Agr., 1948).
- Oosting, H. J., The Study of Plant Communities (Freeman, 1956).
- Overton, W. S., "Estimating the Numbers of Animals in Wildlife Populations," Wildlife Management Techniques, 3d ed. (The Wildlife Society, 1971), pp 403-455.

- Parkinson, D., T. R. G. Gray, and S. T. Williams, Methods of Studying the Ecology of Soil Microorganisms, IBP Handbook 19 (Oxford: Blackwell, 1971).
- Pendleton, R. C., "Uses of Marking Animals in Ecological Studies: Labelling Animals With Radioisotopes," Ecology, Vol 37 (1956), 686-689.
- Peterson, A. M., A Manual of Entomological Equipment and Methods, Part 1 (Edwards Bros., 1934), Part 2 (John S. Swift and Co., 1937).
- Petersen, A. M., A Manual of Entomological Techniques (published by the author, Ohio State University, Columbus, Ohio, 1953).
- Phillips, E. A., Methods of Vegetation Study (New York: Holt, Rinehart, and Winston, Inc., 1959), 107 pp.
- Phillipson, J., ed., Methods of Study in Soil Ecology (Paris: UNESCO, 1970).
- Phillipson, J., ed, Methods of Study in Quantitative Soil Ecology, IBP Handbook No. 18 (Oxford: Blackwell, 1971).
- Pielou, E. C., "The Use of Point-to-Plant Distances in the Study of the Patterns of Plant Populations," J. Ecol., Vol 47 (1959), pp 607-613.
- Platts, W. S., "Geomorphic and Aquatic Conditions Influencing Salmonids and Stream Classification with Application to Ecosystem Classification," U.S. Department of Agriculture, Forest Service, Surface Environment and Mining, Billings, Montana, 1974.
- Poissonet, P. S., J. A. Poissonet, M. P. Godron and G. A. Long, "A Comparison of Sampling Methods in Dense Herbaceous Pasture," J. Range Management, Vol 26 (1973), pp 65-67.
- Rappole, John H., Dwain W. Warner and Mario O. Ramos, "Territoriality and Population Structure in a Small Passerine Community," Amer. Midl. Natur., Vol 97, No. 1 (1977), pp 110-119.
- Reynolds, K. C. and K. Edwards, "A Short-Focus Telescope for Ground Cover Estimation," Ecology, Vol 58 (1977), pp 939-941.
- Ricker, W. E., Computation and Interpretation of Biological Statistics of Fish Populations, Fisheries Research Board of Canada, Ottawa, Canada, 1975.
- Ricker, W. E., "Handbook of Computations for Biological Statistics of Fish Populations," Fishery Res. Board Can. Bull., Vol 119 (1958), pp 1-300.

- Ricker, W. E., ed., Methods for Assessment of Fish Production in Fresh Waters, International Biological Programme Handbook No. 3, 7 Marylebone Road, London, England, NW1, 1968.
- Ricker, W. E., Methods for Assessment of Fish Production in Fresh Waters, IBP Handbook No. 3 (Oxford: Blackwell, 1971).
- Robinette, W. L., R. B. Ferguson and J. S. Gashweiler, "Problems Involved in the Use of Deer Pellet Group Counts," Trans. North Am. Wildlife Conf., Vol 23 (1958), pp 411-425
- Robbins, C. S., "Recommendations for an International Standard for a Mapping Method in Bird Census Work," Audubon Field Notes, Vol 24, No. 6 (1970), pp 723-726.
- Rounsefell, G. A. and J. L. Kask, "How to Mark Fish," Transactions of the American Fisheries Society, Vol 73 (1946), pp 320-363.
- Roughton, R. D., "A Review of Literature on Dendrochronology and Age Determination of Woody Plants," Tech. Bull. 15, Colorado Dept. Fish Game, Denver (1962).
- Sauder, D. W., R. L. Linder, R. B. Dahlgreen and W. L. Tucker, "An Evaluation of the Roadside Technique for Censusing Breeding Waterfowl," Journal of Wildlife Management, Vol 35, No. 3 (1971), pp 538-543.
- Saunders, W. M. and E. G. Williams, "Observations on the Determinations of Total Organic Phosphorus in Soils," J. Soil Sci., Vol 6 (1955), pp 254-267.
- Schnabel, Zoe E., "The Estimation of the Total Fish Population of a Lake," American Mathematics Monthly, Vol 45, No. 6 (1938), pp 348-352.
- Schultz, V., L. L. Eberhardt, J. M. Thomas and M. I. Cochran, A Bibliography of Quantitative Ecology (New York, New York: Halsted Press, John Wiley & Sons, Inc., 1976).
- Schultz, V., Ecological Techniques Utilizing Radionuclides and Ionizing Radiation, A Selected Bibliography, U.S. Atomic Energy Comm., RL0-2213 (Suppl. 1)(1972).
- Schumacher, F. X. and R. W. Eschmeyer, "The Estimate of Fish Population in Lakes or Ponds," Journal of Tennessee Academy of Science, Vol 18, No. 3 (1943), pp 228-249.

- Schwoerbel, J., Methods of Hydrobiology (Freshwater Biology) (Elmsford, N.Y.: Pergamon, 1970).
- Sladeckova, Alena, "Limnological Investigation Methods for the Periphyton (Aufwuchs) Community," Botan. Rev., Vol 28 (1962), pp 286-350.
- Smith, D. W., "Concentrations of Soil Nutrients Before and After Fire," Canadian J. Soil Sci., Vol 50 (1970), pp 18-28.
- Smith, R. L., Ecology and Field Biology (New York: Harper & Row, 1974), 851 pp.
- Southwood, T. R. E., Ecological Methods (London: Methuen, 1966).
- Spencer, D. A., "Porcupine Population Fluctuations in Past Centuries Revealed by Dendochronology," PhD Thesis, University of Colorado, Boulder, Colo. (1958).
- Stickel, Lucille F., "Experimental Analysis of Methods for Measuring Small Mammal Populations," J. Wildlife Management, Vol 10 (1946), pp 140-158.
- Stott, B., "Marking and Tagging," Methods of Assessment of Fish Production in Fresh Waters (Birkenhead, England: Wilman Brothers Ltd., 1968), pp 78-92.
- Taber, R. D., "Marking of Mammals: Standard Methods and New Developments," Ecology, Vol 37 (1956), pp 681-685.
- Taylor, R. F., "An Inexpensive Increment Core Holder," J. Forestry, Vol 34 (1936), pp 814-815.
- Tepper, E. E., Statistical Methods in Using Mark-Recapture Data for Population Estimation (A Compilation), Bibliography No. 4, U.S. Department of Interior, Department Library, Washington, D.C., 1967.
- Tester, J. R., "Techniques for Studying Movements of Vertebrates in the Field," in Radioecology, (New York: Reinhold, 1963), pp 445-450.
- Tiemfeier, O. W. and M. L. Plenert, "A Comparison of Three Methods for Determining the Age of Black-tailed Jackrabbits," J. Mammal., Vol 45 (1964), pp 409-416.
- U.S. Department of Agriculture, "Controlling Erosion on Construction Sites," Soil Conservation Service, Agriculture Information Bulletin 347, Washington, D.C., 1970.
- U.S. Department of Agriculture, "Range Research Methods," U.S.D.A. Misc. Publ. 940, Supt. of Documents, Washington, D.C., 1962.

- U.S. Department of Agriculture, Wildlife Habitat Improvement Handbook, Forest Service, Forest Service Handbook 2609.11, Washington, D.C., 1969.
- U.S. Forest Service, "Range Research Methods; a Symposium," U.S. Dept. Agr. Misc. Publ. 940, 1962.
- U.S. Forest Service, "Techniques and Methods of Measuring Understory Vegetation, a Symposium," Southern Forest Expt. Station, 1958.
- Van Etten, R. C. and C. L. Bennet, Jr., "Some Sources of Error in Using Pellet Group Counts for Censusing Deer," J. Wildlife Management, Vol 29 (1965), pp 723-729.
- Verts, B. J., "Equipment and Techniques for Radio-Tracking Skunks," J. Wildlife Management, Vol 27 (1963), pp 325-339.
- Vestal, A. G., "Minimum Areas for Different Vegetations," Illinois Biol. Monographs, Vol 20 (1949), pp 1-129.
- Wagstaffe, R. J., and J. H. Fidler, The Preservation of Natural History Specimens, Vol 1, The Invertebrates (New York: Philosophical Library, 1955).
- Welch, P. S., 1948 Limnological Methods (New York: McGraw-Hill-Blakiston, 1948).
- Wikum, D. A. and G. F. Shanholtzer, "Application of the Braun-Blanquet Cover-Abundance Scale for Vegetation Analysis in Land Development Studies," Environmental Management, Vol 2, No. 4 (1978), pp 323-329.
- Wilhm, J. L., "Use of Biomass Units in Shannon's Formula," Ecology, Vol 49 (1968), pp 153-156.
- Wodehouse, R. P., Pollen Grains (New York: McGraw-Hill, 1935).
- Wood, E. J. F., "A Method for Phytoplankton Study," Limnol. Oceanog., Vol 7 (1962), pp 32-35.
- Zipin, C., "The Removal Method of Population Estimation," J. Wildlife Management, Vol 22 (1958), pp 325-339.

2. North America

General

Blair, W. F., A. P. Blair, P. Brodkrob, F. R. Cagle and G. A. Moore, Vertebrates of the United States (New York: McGraw-Hill, 1957).

Blair, Frank W., "Distribution Patterns of Vertebrates in the Southern United States in Relation to Past and Present Environments," Zoogeography (1958), pp 433-468.

Cloudsley-Thompson, J. L., Biology of Deserts (New York: Hafnor Publishing Co., 1954), pp 1-224.

Deevy, Edward S., Jr., "The Quantity and Composition of Bottom Fauna of Thirty-Six Connecticut and New York Lakes," Ecol. Mono., Vol 11 (1948), pp 413-455.

Dice, Lee R., "The Sonoran Biotic Province," Ecology, Vol 20 (1939), pp 118-129.

Dice, Lee R., The Biotic Provinces of North America (Ann Arbor: Univ. Michigan Press, 1943), pp 1-78.

Jaeger, Edmund C., The North American Deserts (Stanford, Calif.: Stanford Univ. Press, 1957), pp 1-308.

Jordan, David S., A Manual of the Vertebrate Animals of the Northern United States, 13th ed. (Yonkers-on-Hudson, N. Y.: World Book Co., 1929), 446 pp. Keys to the fishes of the northeastern United States.

Klots, E. B., New Field Book of Freshwater Life (New York: Putnam, 1966).

McAtee, W. L., Wildlife of the Atlantic Coast Salt Marshes, U.S. Dept. Agric., Circ. 520 (1939), pp 1-20.

Needham, J. G. and P. R. Needham, A Guide to the Study of Fresh Water Biology, (San Francisco: Holden-Day, 1962).

Pratt, Henry S., A Manual of Land and Fresh Water Vertebrate Animals of the United States (Exclusive of Birds), 2nd ed. (Philadelphia: P. Blakiston's Son and Co., 1935), 416 pp. Keys and descriptions of representative species of various genera of fishes. Nomenclature not up to date.

Roughton, Robert D., coordinator, Indices of Predator Abundance in the Western United States, U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado, 1976.

Mammals

- Allen, Joel A., "On Mammals From the Santa Cruz Mountains," Bulletin American Museum of Natural History (1893), pp 263-270.
- Allen, Joel Asaph, "The Geographical Distribution of North American Mammals," Bull. Amer. Mus. Nat. Hist., Vol 4 (1892), pp 199-243.
- Anthony, Harold E., Fieldbook of North American Mammals, (New York: G. P. Putnam's Sons, 1928).
- Bailey, Vernon, Mammals of the Southwestern United States (Dover, 1931).
- Barbour, R. W. and W. H. Davis, Bats of North America (Lexington: Univ. Kentucky Press, 1969), 285 pp.
- Blair, W. Frank, "Mammals of the Mesquite Plains Biotic District in Texas and Oklahoma, and Speciation in the Central Grasslands," Texas Jour. Sci., Vol 6 (1954), pp 235-264.
- Booth, E. S., How to Know the Mammals (Dubuque, Iowa: Brown, 1961).
- Broadbooks, Harold E., "Home Ranges and Territorial Behavior of the Yellow Pine Chipmunk, *Eutamias Amoenus*," J. of Mammalogy, Vol 51, No. 2 (1970).
- Buechner, Helmut K., "The Bighorn Sheep in the United States, its Past, Present, and Future," Wildl. Monogr., Vol 4 (1960), pp 1-174.
- Burt, William H. and Richard P. Grossenheider, A Field Guide to the Mammals (Boston: Houghton Mifflin, 1952), 284 pp.
- Cahalane, U. H., Mammals of North America (New York: The Macmillan Company, 1947), 682 pp.
- Caras, Roger A., North American Mammals (New York: Meredith Press, 1967), 578 pp.
- Conaway, C. H. and J. C. Howell, "Observations on the Mammals of Johnson and Carter Counties, Tennessee and Avery County, North Carolina," J. Tenn. Acad. Sci., Vol 28 (1953), pp 53-61.
- Cory, Charles B., The Mammals of Illinois and Wisconsin, Field Mus. Nat. Hist. Publ. 153, Zool. Ser. 11 (1912), pp 1-505.
- Frick, C., Horned Ruminants of North America, Amer. Mus. Nat. Hist. Bull., Vol 39 (1937), pp 1-669.
- Hall, E. R., American Weasels, Univ. Kansas Publ. Mus. Nat. Hist., Vol 4 (1951), pp 1-466.

- Hall, E. R. and K. R. Kelson, The Mammals of North America, 2 Vols (New York: Ronald Press Co., 1959), 1083 pp.
- Hamilton, W. J., American Mammals (New York: McGraw-Hill, 1939).
- Hamilton, W. J., Jr., Mammals of Eastern United States (Ithaca, New York: Comstock Publ. Co., 1943).
- Hartman, C. G., Possums (Austin: Univ. Texas, 1952), 174 pp.
- Hay, K. G., "Beaver Census Methods in the Rocky Mountain Region," Journal of Wildlife Management, Vol 22 (1958), pp 395-402.
- Howell, A. H., "Revision of the North American Ground Squirrels," N. Amer. Fauna, Vol 56 (1938), pp 1-256.
- Ingles, L. C., Mammals of the Pacific States (Stanford: Stanford Univ. Press, 1965).
- Jones, J. K., Jr., D. C. Carter and H. H. Gendway, "Checklist of North American Mammals North of Mexico," Occ. Pop. Mus. Tex. Tech. Univ., No. 12 (1973).
- Larrison, Earl J., Mammals of the Northwest (Washington, Oregon, Idaho, and British Columbia) (Seattle: Audubon Soc., 1976).
- Manning, T. H., "The Northern Red-backed Mouse, Clethrionomys rutilus (Pallas), in Canada," Nat. Mus. Canada, Bull. 144 (1956).
- Miller, Gerrit S. and Remington Kellogg, List of North American Recent Mammals, U.S. National Mus. Bull. 205 (1955).
- Murie, Olaus J., A Field Guide to Animal Tracks (Boston: Houghton Mifflin, 1954).
- Osgood, W. H., "Revision of the Mice of the American Genus Peromyscus," N. Amer. Fauna, Vol 28 (1909), pp 1-285.
- Palmer, Ralph S., The Mammal Guide (New York: Doubleday and Company, Inc., 1954).
- Peterson, R. L., ed., North American Moose (Toronto: Univ. Toronto Press, 1955), 280 pp.
- Rhoades, Sam Nicholson, The Mammals of Pennsylvania and New Jersey (Privately Published, 1903).

Schwartz, Albert and E. P. Odum, "The Woodrats of the Eastern United States," Jour. Mammal., Vol 38 (1957), pp 197-206.

Tomich, Prosper Q., Mammals in Hawaii (Honolulu: Bishop Museum Press, 1969).

Turner, R. W., Mammals of the Black Hills of South Dakota and Wyoming, Univ. Kans. Mus. Nat. Hist. Misc. Publ., Vol 60 (1974), pp 1-178.

Verts, B. J., The Biology of the Striped Skunk (Urbana: Univ. Illinois Press, 1967), 218 pp.

Young, S. P., The Bobcat of North America (Washington, D.C.: The Wildlife Management Institute, 1958), 193 pp.

Young, S. P. and H. H. T. Jackson, The Clever Coyote (Wash., D.C.: The Wildlife Manage. Inst., 1951), 411 pp.

Birds

American Ornithologists' Union, Check-list of North American Birds, 5th ed. (Amer. Orn. Union, 1957).

American Ornithologists' Union, "Thirty-second Supplement to the A.O.U. Check-list of N.A. Birds," Auk, Vol 90 (1973), pp 411-419.

American Ornithologists' Union, "Thirty-third Supplement to the A.O.U. Check-list of N.A. Birds," Auk, Vol 93 (1976), pp 875-879.

Baumgartner, F. M., "Territory and Population in the Great Horned Owl," The Auk, Vol 56 (1939), pp 274-282.

Bent, A. C., Life Histories of North American Birds of Prey, U.S. Nat. Mus. Bull. 167 (1937).

Bent, A. C., Life Histories of North American Blackbirds, Orioles, Tanagers, and Their Allies, U.S. Nat. Mus. Bull. 211 (1958).

Bent, A. C., Life Histories of North American Cuckoos, Goatsuckers, Hummingbirds and Their Allies, U.S. Nat. Mus. Bull. 176 (1940).

Bent, A. C., Life Histories of North American Flycatchers, Swallows, Larks, and Their Allies, U.S. Nat. Mus. Bull. 179 (1942).

Bent, A.C., Life Histories of North American Gallinaceous Birds, U.S. Nat. Mus. Bull. 162 (1932).

Bent, A. C., Life Histories of North American Nuthatches, Wrens, Thrashers, and Their Allies, U.S. Nat. Mus. Bull. 195 (1948).

- Bent, A. C., Life Histories of North American Thrushes, Kinglets and Their Allies, U.S. Nat. Mus. Bull. 196 (1949).
- Bent, A. C., Life Histories of North American Wild Fowl, U.S. Nat. Mus. Bull. 126, Washington D.C., 1923.
- Bent, A. C., Life Histories of North American Woodpeckers, U.S. Nat. Mus. Bull. 174 (1939).
- Bent, A. C., Life Histories of North American Wood Warblers, U.S. Nat. Mus. Bull. 203 (1953).
- Blankenship, L. H., A. B. Humphrey and D. MacDonald, "A New Stratification for Mourning Dove Call-Count Routes," Journal of Wildlife Management, Vol 35, No. 2 (1971), pp 319-326.
- Boeker, E. L. and E. B. Bolen, "Winter Golden Eagle Populations in the Southwest," Journal of Wildlife Management, Vol 36, No. 2 (1972), pp 477-484.
- Booth, Ernest S., Birds of the East (Outdoor Pict., 1962).
- Booth, Ernest S., Birds of the West (Outdoor Pict., 1971).
- Borrer, Donald J., Songs of the Eastern Birds, (Dover, 1970).
- Borrer, Donald J., Songs of Western Birds (Dover, 1970).
- Carlson, Kenneth L. and Laurence C. Binford, Birds of Western North America (Macmillan, 1974).
- Chapman, Frank M., Handbook of Birds of Eastern North America (D. Appleton and Company, 1895; rpt. New York: Dover Publications, 1966), 421 pp.
- Craighead, John J. and Frank C. Craighead, Hawks, Owls, and Wildlife (Stackpole Co., Harrisburg, Pa. and Wildl. Manag. Inst., Washington, D.C., 1956), pp i-xix, 1-443.
- Day, Albert M., North American Waterfowl (Harrisburg, Pa: Stackpole, 1959), 363 p.
- Dorney, R. S., D. R. Thompson, J. B. Hale and R. F. Wendt, "An Evaluation of Ruffed Grouse Drumming Counts," Journal of Wildlife Management, Vol 22 (1958), pp 35-40.
- Douglas, J. A., Bird Populations of Aspen Forests in Western North America (Flack, 1976), 97 pp.

- Forbush, E. H. and J. B. May, Natural History of the Birds of Eastern and Central North America (Boston: Houghton Mifflin Co., 1939).
- Friedmann, H., The Birds of North and Middle America, Part II, U.S. National Mus. Bull. 50 (1950).
- Green, Charlotte G., Birds of the South (Dover, 1975).
- Headstrom, R. A Complete Field Guide to Nests in the United States (New York: Washburn, 1970).
- Jackman, S. M. and J. M. Scott, Literature Review of Twenty Three Selected Forest Birds of the Pacific Northwest, Region 6, U.S. Forest Service (1975), 382 pp.
- Jaques, H. E., How to Know the Land Birds (Dubuque, Iowa: Brown, 1947).
- Jaques, Harry E. and Roy Oliver, How to Know the Water Birds (Wm C. Brown, 1960).
- Johnsgard, P. A., Grouse and Quails of North America (Lincoln: Univ. Nebraska Press, 1973).
- Johnsgard, P. A., North American Game Birds of Upland and Shoreline (Lincoln: Univ. Neb. Press, 1975), 183 pp.
- Johnsgard, P., Waterfowl North America (Bloomington: Indiana Univ. Press, 1976).
- Kessel, Brina, "Distribution and Migration of the European Starling in North America," Condor, Vol 55, (1953), pp 49-67.
- Kimball, J. W., "The Crowing Count Pheasant Census," Journal of Wildlife Management, Vol 13 (1949), pp 101-120.
- Kortright, F. H., Ducks, Geese and Swans of North America, Harrisburg, Pa.: Stackpole, 1942), 476 pp.
- Kozicky, E. L., T. A. Bancroft and P. G. Homeyer, "An Analysis of Woodcock Singing Ground Counts, 1948-1952," Journal of Wildlife Management, Vol 18 (1954), pp 259-266.
- Norton, H. W., T. B. Scott, W. R. Hanson and W. D. Klimstra, "Whistling Cock Indices and Bobwhite Populations in Autumn," Journal of Wildlife Management, Vol 25, No. 4 (1961), pp 398-403.
- Palmer, R., Handbook of North American Birds, Vol. I (New Haven, Conn.: Yale University Press, 1962).
- Pearson, T. Gilbert, Birds of America (New York: University Society, 1923).

Peterson, Roger T., A Field Guide to the Birds (Boston: Houghton Mifflin, 1947).

Peterson, Roger T., A Field Guide to the Birds of Texas and Adjacent States (Boston: Houghton Mifflin, 1963), 304 pp.

Peterson, Roger T., A Guide to Western Birds (Boston, Mass.: Houghton Mifflin, 1961), 309 pp.

Pough, R. H., Audubon Bird Guides: Vol 1, Eastern Land Birds; Vol 2, Water Birds (Garden City, N.Y.: Doubleday, 1946-1951).

Pough, R. H., Audubon Western Bird Guide (Garden City, N.Y.: Doubleday, 1957).

Pulich, Warren M., The Golden-Cheeked Warbler (Austin, Texas: Texas Parks and Wildlife Department, 1976).

Reed, Chester Albert, North American Birds' Eggs in New York (New York: Dover Publications, 1904), 372 pp.

Ridgway, R., The Birds of North and Middle America, Bull. U.S. National Mus., Vol 50, No. 6 (1914), pp 1-882.

Robbins, C. S., B. Brunn and H. S. Zim, Birds of North America (New York: Golden, 1966).

Robbins, C. S. and W. T. Van Velzen, The Breeding Bird Survey, 1966, Special Scientific Report, Wildlife No. 102, Washington, D.C., 1967, pp iv and 43.

Robel, R. J., D. J. Dick and G. F. Krause, "Regression Coefficients Used to Adjust Bobwhite Quail Whistle Count Data," Journal of Wildlife Management, Vol 33, No. 3 (1969), pp 662-668.

Rosene, W. J., "A Summer Whistling Cock Count of Bobwhite as an Index to Wintering Populations," Journal of Wildlife Management, Vol 21 (1957), pp 153-158.

Saunders, A. A., A Guide to Bird Song (New York: Doubleday, 1959).

Sheldon, W. G., The Book of the American Woodcock (Amherst: Univ. Mass. Press, 1967).

Sprunt, Alexander, North American Birds of Prey (New York, 1955).

Wight, H. M. and E. B. Baysinger, Mourning Dove Status Report, U.S. Department of the Interior, Fish and Wildlife Service, Special Scientific Report No. 73, 1963.

Reptiles and Amphibians

- Altig, Ronald, "A Key to the Tadpoles of the Continental United States and Canada," Herpetologica, Vol 26 (1970), pp 180-207.
- Babcock, Harold L., Field Guide to New England Turtles, Boston: Natural History Guides, No. 2, New England Mus. of Nat. Hist., 1938.
- Babcock, Harold L., The Snakes of New England, Boston: Natural History Guides, No. 1, Boston Soc. of Nat. Hist., 1929.
- Babcock, Harold L., "The Turtles of New England," Memoirs Boston Soc. of Nat. Hist., Vol 8 (1919), pp 323-431.
- Barker, Will, Familiar Reptiles and Amphibians of America (New York: Harper and Row, 1964), 220 pp.
- Bishop, S. C., Handbook of Salamander (Ithaca, New York: Comstock Publ. Co., 1943), 555 pp.
- Blair, Albert P. and Fred R. Cagle, Vertebrates of the United States, 2nd ed. (New York: McGraw-Hill, 1968). (Sections on amphibians and reptiles.)
- Brodie, E. D., Jr. "Western Salamander of the Genus *Plethodon*: Systematics and Geographic Variation" Herpetologica, Vol 26 (1970), pp 468-516.
- Carr, A., Handbook of Turtles (Ithaca, N.Y.: Comstock, 1952), 542 pp.
- Cochran, Doris M., Living Amphibians of the World (Garden City, N.Y.: Doubleday & Co., Inc., 1961).
- Cochran, Doris M., and Coleman J. Goin, The New Field Book of Reptiles and Amphibians (New York: Putnam, 1970).
- Collins, J. T., J. F. Huheey, J. L. Knight and H. M. Smith, Standard Common and Current Scientific Names for North American Amphibians and Reptiles, SSAR, Misc. Publ. Cir. No. 7 (1978).
- Conant, Roger, Reptiles and Amphibians of the Northeastern States, 3rd ed. (Philadelphia: Zool. Soc. of Philadelphia, 1957).
- Conant, Roger, A Field Guide to Reptiles and Amphibians of the United States and Canada East of the 100th Meridian (Boston: Houghton Mifflin Co., 1958), pp i-xv, 1-366.

- Cope, E. D., The Crocodilians, Lizards, and Snakes of North America, U.S. Nat'l. Mus. Rep. for 1898 (1900), pp 153-1270.
- Dickerson, Mary C., Frog Book (1906; rpt. New York: Dover Publications, 1969).
- Dickerson, Mary C., North American Toads and Frogs, With a Study of the Habits and Life Histories of Those of the Northeastern States (Peter Smith, 1914; rpt. New York: Dover Publications, 1969).
- Ditmars, R. L., "Serpents of the Eastern States," N. Y. Zool. Soc. Bull., Vol 32, No. 3, pp 82-120.
- Ditmars, R. L., The Reptiles of North America (New York: Doubleday, Doran, and Co., Inc., 1936), 476 pp.
- Ditmars, R., Fieldbook of North American Snakes (Garden City, N.Y.: Doubleday, 1949).
- Dunn, Emmett Reid, "The Herpetological Fauna of the Americas," Copeia (1931), pp 106-119.
- Ernst, C. H. and R. W. Barbour, Turtles of the United States (Lexington: Univ. Kentucky Press, 1972), 347 pp.
- Gloyd, Howard K., "The Rattlesnakes, Genera Sistrurus and Crotalus," Chic. Acad. Sci. Spec. Publ. 4 (1940), 266 pp.
- Highton, R., "Revision of North American Salamanders of the Genus Plethodon," Bull. Fla. State Mus., Vol 6 (1962), pp 235-367.
- Hugheey, Jame E. and Arthur Stuplea, Amphibians and Reptiles of Great Smoky Mountains (Univ. Tenn. Press, 1967).
- Kauffeld, Carl, Snakes and Snake Hunting (Garden City, N.Y.: Hanover House, 1957).
- Klauber, Laurence M., Rattlesnakes: Their Habits, Life Histories and Influence on Mankind, 2 Vols (Berkeley: Univ. Calif. Press, 1956).
- Leviton, Alan E., Reptiles and Amphibians of North America (New York: Doubleday, 1972).
- Marr, John C., "Notes on Amphibians and Reptiles From the Central United States," Amer. Midl. Nat., Vol 32, No. 2 (1944), pp 478-490.
- Martof, B. S., "Territoriality in the Green Frog Rana clamitans," Ecology, Vol 34 (1953), pp 165-174.

- Oliver, James A., The Natural History of North American Amphibians and Reptiles (Princeton: D. Van Nostrand Co., Inc., 1955).
- Orton, Grace L., "Key to the Genera of Tadpoles in the United States and Canada," American Midland Naturalist, Vol 47 (1952), pp 382-395.
- Perkins, C. B., A Key to the Snakes of the United States, 2nd ed., San Diego Zool. Soc. Bull. 24 (1949), 79 pp.
- Pickwell, G., Amphibians and Reptiles of the Pacific States (reprint, New York: Dover, 1972).
- Pope, C., Turtles of the United States and Canada (New York: Knopf, 1939).
- Pope, Clifford H., Snakes of the Northeastern United States (New York: New York Zool. Soc., 1946).
- Schmidt, K. and D. D. Davis, Field Book of Snakes of the United States and Canada (New York: Putnam, 1941).
- Schmidt, Karl P., A Checklist of North American Amphibians and Reptiles, 6th ed. (Chicago: Amer. Soc. Ichthy. and Herp., 1953).
- Shaw, Charles E. and Sheldon Campbell, Snakes of the American West (New York: Knopf, 1974).
- Smith, H. M., Handbook of Lizards; Lizards of the United States and Canada, (Ithaca, N.Y.: Comstock Publ. Co., 1949), 557 pp.
- Stebbins, Robert C., Amphibians and Reptiles of Western North America (New York: McGraw-Hill Book Co., Inc., 1954), 536 pp.
- Stebbins, Robert C., Amphibians of Western North America (Univ. Calif. Press, 1951).
- Stebbins, Robert C., A Field Guide to Western Reptiles and Amphibians (Boston: Houghton Mifflin, 1966), 279 pp.
- Stejneger, Leonhard and Thomas Barbour, A Check List of North American Amphibians and Reptiles, 5th ed., Harvard Univ. Mus. Compar. Zool. Bull., Vol 93, No. 1, pp 1-260.
- Wright, A. H. and A. A. Wright, Handbook of Frogs and Toads (Ithaca: Cornell Univ. Press, 1949), 640 pp.
- Wright, A. H. and A. A. Wright, Handbook of Snakes of the United States and Canada, 2 Vols (Ithaca, N.Y.: Cornell Univ. Press, 1957), 1105 pp.

Zim, Herbert S. and Hobart M. Smith, Reptiles and Amphibians, Golden Nature Guide (New York: Simon & Schuster, 1953), pp 116-153.

Fish

Bailey, R. M., H. E. Winn and C. L. Smith, "Fishes from the Escambia River, Alabama and Florida, with Ecologic and Taxonomic Notes," Proc. Acad. Nat. Sci. Phila., Vol 106 (1954), pp 109-164.

Bailey, Reeve M., et al., A List of Common and Scientific Names of Fishes From the United States and Canada, 2nd ed., Am. Fish Soc., Publ. No. 2 (1960), 102 pp.

Bailey, R. M. (Chairman), A List of Common and Scientific Names of Fishes From the United States and Canada, 3rd ed., Am. Fish. Soc. Spec. Publ. No. 6 (1970), 150 pp.

Barnickol, P. G. and W. C. Starrett, "Commercial and Sport Fishes of the Missouri River Between Caruthersville, Missouri, and Dubuque, Iowa," Illinois Nat. Hist. Survey Bull., Vol 25, No. 5 (1951), pp 267-350.

Cahn, Alvin Robert, An Ecological Study of Southern Fishes, Ill. Biol. Mono., Vol 11 (1927), pp 1-151.

Carlander, K. D., Handbook of Freshwater Fishery Biology, Vol 1 (Ames: Iowa State Univ. Press, 1969), 752 pp.

Clemens, C. W. and G. V. Wilby, Fishes of the Pacific Coast of Canada, Bull. Fish. Res. Bd. Canada, No. 68, 2nd ed. (1961), 443 pp.
Includes many anadromous fishes ranging into Alaska.

Eddy, S., How to Know the Freshwater Fishes, 2nd ed. (Dubuque: William C. Brown Co., 1969), 286 pp.

Eddy, Samuel and Thaddeus Surber, Northern Fishes (Branford, 1943).

Evermann, Barton W., "The Fishes of Kentucky and Tennessee: A Distributional Catalogue of the Known Species," Bull. U.S. Bur. Fish., Vol 35 (1918), pp 295-368.

Fowler, H. W., A Study of the Fishes of the Southern Piedmont and Coastal Plain, Acad. Nat. Sci. Philadelphia, Monogr. No. 7 (1945), 408 pp.

Gunter, Gordon, "A List of the Fishes of the Mainland of North and Middle America Recorded from Both Freshwater and Sea Water," Am. Midl. Nat., Vol. 28 (1942), pp 305-356. A list of the marine fishes known to enter freshwater and the freshwater fishes entering salt water. No keys or illustrations.

- Hamilton, A. L., A Classification of the Nearctic Chironomidae, Fish. Res. Bd. Can., Tech. Rept. No. 124 (1969).
- Herald, Earl S., Fishes of North America (Doubleday, 1972).
- Hubbs, C. L., A Check-list of Fishes of the Great Lakes and Tributary Waters, With Nomenclatorial Notes and Analytical Keys, Univ. Michigan Mus. Zool. Misc. Publ. 15 (1926), 77 pp.
- Hubbs, Carl L., "Fishes of the Desert," Biol., Vol 22 (1940), pp 61-69.
- Jordan, David Star, "The Distribution of Freshwater Fishes," Ann. Rept. Smithsonian Inst. for 1927 (1928), pp 355-385.
- Jordan, David S. and Barton W. Evermann, The Fishes of North and Middle America, Bull. U.S. Nat. Mus., No. 47, in 4 parts (1896-1900), 3313 pp. Out of date but still the classical work covering all marine fishes and freshwater fishes of North America known at the time of publication. With keys, ranges, descriptions and some illustrations.
- Koelz, Walter, "Coregonid Fishes of Northeastern North America," Papers Mich. Acad. Sci., Arts, and Letters, Vol. 13 (1931) pp 303-432. Detailed descriptions of the coregonid fishes found in waters other than the Great Lakes in northeastern North America.
- LaMonte, Francesca, North American Game Fishes (Garden City: Doubleday, Doran, 1945), xiv, 202 pp. Descriptions and ranges of salt and freshwater game fishes with keys and record weights and lengths. Illustrated.
- Miller, R. R., The Cyprinodont Fishes of the Death Valley System of Eastern California and Southwestern Nevada, Misc. Pub. Mus. Zool., Univ. Mich., No. 68 (1948), 155 pp.
- Nichols, John T., Representative North American Fresh-water Fishes (New York: Macmillan, 1942), 128 pp. Descriptions, ranges, and habits of 60 representative North American Fishes. Illustrated but no keys.
- Schrenkeisen, Ray, Field Book of Fresh-water Fishes of North America North of Mexico (New York: G. P. Putnam's Sons, 1938), xii-312 pp. Description and ranges of the freshwater fishes of the United States attempting to list all species, many of which are not considered valid. Nomenclature not up to date. No keys. Illustrated.
- Zim, H. S. and H. H. Shoemaker, Fishes (New York: Simon and Schuster, 1956), 160 pp. A popular illustrated guide to 278 representative salt and freshwater fishes.

Insects

- Ahlstrom, E. H., "The Deep Water Plankton of Lake Michigan, Exclusive of the Crustacea," Trans. Amer. Microscope Soc., Vol 55 (1936), pp 286-299.
- Alexander, R. D., "The Taxonomy of the Field Crickets of the Eastern United States (Orthoptera: Gryllidae: Acheta), Ann. Ent. Soc. Amer., Vol 50 (1957), pp 504-602.
- Alexander, Richard D. and Donald J. Borror. 1956. The Songs of Insects (1956; Boston: Houghton Mifflin, since 1966). A 12-inch LP in the Sounds of Nature series.
- Anderson, L. D., "A Monograph of the Genus Metrobates (Hemiptera, Gerridae)," Univ. Kans. Sci. Bull., Vol 20, (1932), pp 297-311.
- Arnett, Ross H., Jr., The Beetles of the United States (A Manual for Identification), (Ann Arbor, Mich.: The Amer. Entomol. Inst., 1968).
- Arnett, R. H., Jr., Guide to the Orders of Insects (Biol. Res. Inst., 1973).
- Banks, Nathan and Thomas E. Snyder, A Revision of the Nearctic Termites, Bull. No. 108 (1920), U.S. Natl. Museum.
- Barber, H. S., "North American Fireflies of the Genus Photuris," Smithsonian Misc. Coll., Vol 117 (1951), pp 1-58.
- Barker, Will, Familiar Insects of America (Harper and Row, 1960).
- Barnes, William (and others, chiefly J. McDunnough), 1911-1924. Contributions to the Natural History of the Lepidoptera of North America (Decatur, Illinois: The Review Press, 1911-1924).
- Barnes, William and Foster H. Benjamin, List of the Diurnal Lepidoptera of Boreal America North of Mexico, Bulletin of the Southern California Academy of Sciences, Vol 25 (1926).
- Barnes, William and J. McDunnough, Check-list of the Lepidoptera of Boreal America, Bulletin of Southern California Academy of Science (1917).
- Bates, Marston, The Natural History of Mosquitoes (New York: MacMillan Co., 1949), 379 pp.
- Blackman, Mulsby Willett, Notes on Insects Bred From the Bark and Wood of the American Larch, Technical Publication No. 10 at the Syracuse University (1876).

- Blatchley, W. S., Heteroptera or True Bugs of Eastern North America With Special Reference to the Faunas of Indiana and Florida (Nature Publ. Co., 1926), 1116 pp.
- Blatchley, W. S., Orthoptera of Northeastern America (Indianapolis: Nature Publ. Co., 1920), 784 pp.
- Blatchley, Willis S. and Charles W. Leng, Rhynchophora of Weevils of Northeastern North America (Indianapolis, Ind.: Nature Publishing Co., 1916).
- Bohart, Richard M., "A Revision of the Strepsiptera With Special Reference to the Species of North America," Calif. Univ. Pub. Entomol., Vol 7 (1941), pp 91-160.
- Borror, D. J. and D. M. DeLong, An Introduction to the Study of Insects (New York: Holt, Rinehart, and Winston, 1970).
- Borror, Donald J. and Richard E. White, A Field Guide to the Insects of America North of Mexico (Houghton Mifflin, 1970).
- Brues, C. T., A. L. Melander and F. M. Carpenter, Classification of Insects, Bull. Mus. Comp. Zool., Harvard Univ., Vol 73 (1954), pp vi + 1-917.
- Carpenter, Frank M., "A Revision of Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae, and Dilaridae (Neuroptera)," Proc. Amer. Acad. Arts Sci., Vol 74 (1940), pp 193-280.
- Carpenter, Frank M., "Revision of Nearctic Mecoptera," Bull. Mus. Comp. Zool., Harvard Univ., Vol 72 (1931), pp 205-277.
- Carpenter, S. J. and W. J. LaCrosse, Mosquitoes of North America (North of Mexico), (Univ. Calif. Press, 1955), 360 pp.
- Casey, T. L., I--Additions to the Known Coleoptera of North America, Mem. Coleoptera, Vol XI (1921), pp 1-347.
- Chu, H. F., How to Know the Immature Insects (Dubuque, Iowa: William C. Brown, 1949).
- Claassen, P. W., Plecoptera Nymphs of North America (North of Mexico), Publ. Thomas Say Found., Vol 3 (1931), pp 1-199.
- Comstock, J. H. and A. B. Comstock, How to Know the Butterflies (Ithaca, N.Y.: Comstock Publ. Co., 1936).
- Corbet, Philip S., A Biology of Dragonflies (Chicago: Quadrangle Books).

- Creighton, W. S., The Ants of North America, Bull. Mus. Comp. Zool. Harvard Coll., Vol 104 (1950), pp 1-585.
- Curran, Charles H., The Families and Genera of North American Diptera, 2nd rev. ed. (Woodhaven, N.Y.: Henry Tripp, 1965).
- Dickerson, M. C., Moths and Butterflies (Boston: The Athenian Press, Ginn & Co., 1901), 344 pp.
- Dillon, E. and L. S. Dillon, A Manual of Common Beetles of Eastern North America (New York: Harper & Row; Dover reprint, 1961).
- Edwards, J. Gordon, Coleoptera or Beetles East of the Great Plains (Ann Arbor, Mich.: Edwards, 1949).
- Ehrlich, P. R. and A. H. Ehrlich, How to Know the Butterflies (Dubuque, Iowa: William C. Brown Co., 1961), 262 pp.
- Eliot, I. M. and C. G. Soule, Caterpillars and Their Moths (New York: The Century Co., 1902), 302 pp.
- Essig, E. O., Insects and Mites of Western North America, (New York: Macmillan, 1958).
- Ewing, Henry E., A Manual of External Parasites (Springfield, Ill.: Charles C. Thomas, 1929).
- Ewing, Henry E. and Irving Fox, The Fleas of North America, U.S.D.A. Misc. Pub. No. 500.
- Ferris, Gordon F., Atlas of the Scale Insects of North America, 6 vols (Stanford Univ., Calif.: Stanford Univ. Press, 1937-53).
- Ferris, Gordon F., The Sucking Lice, Mem. No. 1, Pacific Coast Entomol. Soc. (1951).
- Frison, Theodore H., Studies of North American Plecoptera, With Special Reference to the Fauna of Illinois, Bull. Ill. Natural Hist. Surv., Vol 22 (1942), pp 231-355.
- Grossbeck, John A., Insects of Florida. IV. Lepidoptera, Bulletin of the American Museum of Natural History, Vol 37, Art. I (1917), New York, New York. (Edited and with addenda by Frank E. Watson.)
- Gurney, Ashley B., "A Synopsis of the Order Zoraptera, with Notes on the Biology of Zorotypus hubbardi Caudell," Proc. Entomol. Soc. Wash., Vol 40 (1938), pp 57-87.

- Haddock, James D., "The Biosystematics of the Caddis Fly Genus Nectopsyche in North America With Emphasis on the Aquatic Stages," Amer. Midl. Natua., Vol 98, No. 2 (1947), pp 382-421.
- Hayes, William P., "Prairie Insects," Ecol., Vol 8 (1927), pp 238-250.
- Heinrich, C., American Moths of the Subfamily Phycitinae, U.S. Nat. Mus. Bull. 207 (1956), pp 1-581.
- Helfer, J. R., How to Know the Grasshoppers, Cockroacher, and Their Allies (Dubuque, Iowa: Brown, 1963).
- Hitchcock, S. W., "Alloperla (Chloroperlidae: Plecoptera) of the Northeast With a Key to Species," J. N.Y. Entomol. Soc., Vol 76 (1968), pp 39-46.
- Holland, W. J., The Butterfly Book, (Garden City, N.Y.: Doubleday, 1949).
- Holland, W. J., The Moth Book. A Guide to the Moths of North America (New York: Doubleday, 1903; rpt. New York: Dover, 1968), 479 pp.
- Howe, R. H., Manual of the Odonata of New England, Mem Thoreau Mus. Nat. Hist. II, Vol I-VI (1917-20), 98 pp.
- Hubbard, C. A., Fleas of Western North America (Ames: Iowa Stat. Coll. Press, 1947), 533 pp.
- Hungerford, H. B., The Biology and Ecology of Aquatic and Semiaquatic Hemiptera, Univ. Kans. Sci. Bull., Vol 11 (1920), pp 1-341.
- Hungerford, H. B., The Loricidae of the Western Hemisphere, Univ. Kans. Sci. Bull., Vol 32 (1948), pp 1-827.
- Jaques, H. E., How to Know the Beetles (Dubuque, Iowa: Brown, 1951).
- Jaques, H. E., How to Know the Insects (Dubuque, Iowa: Brown, 1947).
- Klots, Alexander B., A Field Guide to the Butterflies of North America, East of The Great Plains (Boston, Mass.: Houghton Mifflin, 1951), 349 pp.
- Klots, Alexander and Elsie B. Klots, Insects of North America (Doubleday, 1971).
- Lindsey, A. W., E. L. Bell and R. C. Williams, Jr., The Hesperioidea of North America, Denison University Bulletin, Vol 26 (1931), Granville, Ohio.
- Lutz, F. E., Field Book of Insects, 3d rev. ed. (New York: Putnam, 1935).

- Lutz, Frank E., Field Book of Insects of U.S. and Canada, Nature Field Bk. (Putnam, 1948).
- Macy, R. W. and H. H. Shepard, Butterflies (Univ. Minn. Press, 1941).
- McDunnough, J. 1938. Check List of the Lepidoptera of Canada and the United States of America: Part I, Macrolepidoptera, Memoirs of the Southern California Academy of Science, Vol I (1938), Los Angeles, California.
- Metcalf, Zeno P., "Fulgoridae of Eastern North America," Jour. Elisha Mitchell Sci. Soc., Vol 38 (1923), pp 139-230.
- Mitchell, T. B., Bees of the Eastern United States, Vol 1, N. C. Agric. Exp. Stn. Tech. Bull. 141 (1960).
- Mitchell, T. B., Bees of the Eastern United States, Vol 2, N. C. Agric. Exp. Stn. Tech. Bull. 152 (1962).
- Morgan, Ann H., Field Book of Ponds and Streams. New York: Putnam, 1930).
- Muesebeck, Carl F. W., et al., Hymenoptera of America North of Mexico; Synoptic Catalogue, U.S.D.A. Agric. Monog. No. 2 (1951). First Supplement, 1958; Second Supplement, 1967, by Karl V. Krombein, et al.
- Needham, James G. and Peter W. Claassen, A Monograph of the Plecoptera or Stoneflies of America North of Mexico, Publ. No. 2 (1925). Thomas Say Foundation.
- Needham, James G. and Hortense B. Heywood, A Handbook of the Dragonflies of North America (Springfield, Ill.: Charles C. Thomas, 1929).
- Needham, James G., Jay R. Traver and Tin-Chi Hsu, The Biology of Mayflies (Ithaca, N.Y.: Comstock, 1935).
- Needham, J. G., and M. J. Westfall, Jr., A Manual of the Dragonflies of North America (Berkeley: University of California Press, 1955).
- Nelson, Dick and Sharon Nelson, Easy Field Guide to Desert Insects and Their Relatives of the Southwest (Tecolote Press, 1974).
- Parfin, Sophy I. and Ashley B. Gurney, "The Spongillaflies, With Special Reference to Those of the Western Hemisphere (Sisyridae, Neuroptera)," Proc. U.S. Natl. Museum, Vol 105 (1956), pp 421-529.
- Pearman, J. V., "The Taxonomy of the Psocoptera; Preliminary Sketch," Proc. Roy. Entomol. Soc. London, Ser. B., Vol 5 (1936), pp 58-62.

- Roback, S. S., The Adults of the Subfamily Tanypodinae (= Pelopiinae) in North America (Diptera: Chironomidae, Acad. Nat. Sci. Phila. Monogr., Vol 17 (1970), pp 1-410.
- Ross, Edward S., "A Revision of the Embioptera, or Webspinners, of the New World," Proc. U.S. Natl. Museum, Vol 94 (1944), pp 401-504.
- Scott, Harold G., "Collembola: Pictorial Keys to the Nearctic Genera," Annals Entomol. Soc. Amer., Vol 54 (1961), pp 104-113.
- Snelling, R. R., "The Ant Genus Conomyrma in the United States," Contrib. Sci. Nat. Hist. Mus., Los Angeles Co., Calif., Vol 238 (1973), pp 1-6.
- Snyder, Thomas E., Order Isoptera--the Termites of the United States and Canada (New York: Natl. Pest Control Assn., 1954).
- Snyder, Thomas E., "Our Native Termites," Smiths. Inst. Rept. for 1964 (1965), pp 497-506.
- Stannard, Lewis J., Jr. 1957. The Phylogeny and Classification of the North American Genera of the Suborder Tubulifera (Thysanoptera), Ill. Biol. Monog. No. 25 (1957).
- Stone, Alan, et al., A Catalogue of the Diptera of America North of Mexico, U.S.D.A. Agric. Handbook No. 276 (1965).
- Swain, Ralph B., The Insect Guide (Garden City, N.Y.: Doubleday & Co., Inc., 1948).
- Swan, Lester A. and Charles S. Papp, Common Insects of North America (Harper and Row, 1972).
- Tuxen, S. L., The Protura. A Revision of the Species of the World With Keys for Determination (Paris: Hermann, 1964).
- Ulinger, Robert L., ed., Aquatic Insects of California, With Keys to North American Genera and California Species (Berkeley: Univ. California Press, 1956).
- Wirth, W. W., "The Brine Flies of the Genus Ephydra in North America (Diptera: Ephydriidae)," Ann. Entomol. Soc. Amer., Vol 64 (1971), pp 357-377.

Other Invertebrates

Agassiz, Alexander, N. American Starfishes, (Cambridge MA.: Cambridge, Welch, Bigelow, and Company, University Press, 1877).

Ahlstrom, E. H., "A Revision of the Rotatorian Genera Brachionus and Platytas With Descriptions of One New Species and Two New Varieties," Bull. Amer. Mus. Natur. Hist., Vol 77 (1940), pp 143-184.

Baker, E. W., J. H. Camin, F. Cunliffe, T. A. Woolley and C. E. Yunker, Guide to the Families of Mites, Contrib. No. 3, Inst. Acarology, Univ. Maryland (1958).

Bailey, R. M. and C. E. Bond, "Four New Species of Freshwater Sculpins, Genus Cottus, from Western North America," Occ. Pap. Mus. Zool., Univ. Mich., No. 634 (1963), 27 pp.

Brinkhurst, R. O., "Studies on the North American Aquatic Oligochaeta, I. Naididae and Opisthocystidae," Proc. Acad. Nat. Sci. Philadelphia, Vol 116 (1964), pp 195-230.

Brinkhurst, R. O., "Studies on the North American Aquatic Oligochaeta, II. Tubificidae," Proc. Acad. Nat. Sci. Phila., Vol 117 (1965), pp 117-172.

Brinkhurst, R. O., "Studies of the North American Aquatic Oligochaeta, III. Lumbriculidae and Additional Notes and Records of Other Families," Proc. Acad. Nat. Sci. Phila., Vol 118 (1966), pp 1-33.

Brinkhurst, R. O. and B. G. M. Jamieson, Aquatic Oligochaeta of the World (Toronto: Univ. Toronto Press, 1971), 860 pp.

Brooks, J. L., "The Systematics of North American Daphnia," Mem. Conn. Acad. Art. Sci., Vol 13 (1957), pp 1-180.

Burch, J. B., How to Know the Eastern Land Snails (Dubuque, Iowa: Brown, 1962).

Clench, W. J. and R. D. Turner, "Freshwater Mollusks of Alabama, Georgia, and Florida From the Escambia to the Suwannee River," Bull. Fla. State Mus., Vol 1 (1956), pp 97-239.

Comstock, J. H., ed. by W. J. Gertsch, The Spider Book, 2d rev. ed. (Garden City, N.Y.: Doubleday, 1940).

Cooper, Arthur, "North American Pseudophyllidea Cestod." Illinois Biological Monographs, Vol IV, No. 4 (1919).

- Corliss, J. O., "An Illustrated Key to the Higher Groups of the Ciliate Protozoa, With Definition of Terms," J. Protozool., Vol 6 (1959), pp 265-281.
- Cvancara, A. M., "Mussels (Unionidae) of the Red River Valley in North Dakota and Minnesota, U.S.A.," Malacologia, Vol 10 (1970), pp 57-92.
- Davis, Charles C., The Marine and Freshwater Plankton (East Lansing: Michigan St. Univ. Press, 1955), 562 pp.
- Eaton, T. H., Jr., "Earthworms of the Northeastern United States," J. Wash. Acad. Sci., Vol 32 (1942), pp 242-249.
- Edney, E. B., "Desert Arthropods," in Desert Biology, Vol II, ed. G. W. Brown (New York: Academic Press, 1974).
- Emerton, J. H., The Common Spiders of the United States, (reprint, New York: Dover, 1961).
- Gertsch, W. J., American Spiders (New York: Van Nostrand, 1949), 285 pp.
- Hansen, Hans-Jacob, The Crustacea Euphaubiacea of the U.S., U.S. Nat'l Museum Proceedings, Wash. (1915).
- Hobbs, H. H., Jr., Cray Fishes (Astacidae) of North and Middle America, Biota of Freshwater Ecosystems Identification Manual No. 9, U.S.E.P.A. Water Pollution Control Res. Series, (1972), 173 pp.
- Hyman, L. H., "Coelenterata," in Ward and Whipple's Freshwater Biology, ed. W. T. Edmondson, 2nd ed. (New York: John Wiley, 1959), pp 313-322.
- Hyman, L. H. and E. R. Jones, "Turbellaria," in Ward and Whipple's Freshwater Biology, ed. W. T. Edmondson, 2nd ed. (New York: John Wiley), pp 323-365.
- Jahn, T. L., How to Know the Protozoa (Dubuque, Iowa: Brown, 1949).
- Kaston, B. J. and E. Kaston, How to Know the Spiders, 2nd ed. (Dubuque: William C. Brown, Co., 1953), 220 pp.
- Kenk, R. N., "Freshwater Triclad (Turbellaria) of North America, I. The Genus Planaria," Proc. Biol. Soc. Wash., Vol 82 (1969), pp 539-558.
- Kenk, R., "Freshwater Triclad (Turbellaria) of North America, V. The Genus Polycetes," Smithsonian Cont. Zool., Vol 135 (1973), pp 1-15.

- Krecker, F. H., "The Fauna of Rock Bottom Ponds," Ohio Jour. Sci., Vol 19 (1919), pp 427-474.
- Krishna, K., "Taxonomy, Phylogeny, and Distribution of Termites," in Biology of Termites, ed. K. Krishna and F. M. Weesner (New York: Academic Press, 1970), pp 127-152.
- Miller, Edwin Lynn, "Studies on North American Cercariae," Illinois Biological Monographs, Vol xiv, No. 2 (1936), 125 pp.
- Miner, Roy W., Fieldbook of Seashore Life (New York: Putnam, 1950).
- Pennak, Robert W., Freshwater Invertebrates of the United States (New York: Ronald Press Co., 1953), 769 pp.
- Pilsbry, H. A., Land Mollusca of North America, Acad. Nat. Sci. Monogr. 3 (1939).
- Pratt, H. S., Manual of the Common Invertebrate Animals (New York: McGraw-Hill-Blakiston, 1953).
- Richardson, H., A Monograph of the Isopods of North America, U.S. Nat. Mus. Bull. No. 54 (1905), pp 1-727.
- Van Cleave, H. J., Acantocephala of North American Mammals, Univ. Illinois Biol. Monogr. 23 (Urbana: Univ. Illinois Press, 1953).
- Van der Shalie, H. and A. Van der Shalie., "The Mussels of the Mississippi River," Amer. Midl. Natur., Vol 44 (1950), pp 448-466.
- Webb, W. F., United States Mollusca (New York: Bookcraft, 1942), 220 pp.

Plants

- Abrams, L., Illustrated Flora of the Pacific States, Vol III (Stanford: Stanford Univ. Press, 1951).
- Allen, J. A., "The Flora of the Prairies," Amer. Nat., Vol 4 (1870), pp 577-585.
- Baers, H., How to Know the Western Trees (Dubuque, Iowa: Brown, 1955).
- Batson, Wade T., A Guide to the Genera of Native and Commonly Introduced Ferns and Seed Plants (New York: John Wiley & Sons, Inc., 1977), 203 pp.
- Benson, L. and R. A. Darrow, The Trees and Shrubs of Southwestern Deserts (Tuscon: Univ. Ariz. Press, 1954).

- Benson, Lyman and Robert Darrow, A Manual of Southwestern Desert Trees and Shrubs, Univ. Arizona Biol. Sci. Bull., Vol 6 (1944), pp 1-411.
- Bessey, E. A., Morphology and Taxonomy of Fungi (New York: The Blakiston Co., 1950).
- Blake, S. F. "State and Local Fern Floras of the United States," reprinted from American Fern Journal, Vol 40 (1950), pp 148-65.
- Braun, E. Lucy, Deciduous Forest of Eastern North America (Philadelphia: Blakiston Co., 1950), 596 pp.
- Breckon, G. J. and M. G. Barbour, "Review of North American Pacific Coast Vegetation," Madroño, Vol 22 (1974), pp 333-360.
- Britton, N. L. and J. N. Rose, The Cactaceae, 2 vols. (reprint, New York: Dover, 1937).
- Britton, Max E., "Vegetation of the Arctic Tundra," 18th Biol. Colloq Oregon St. Coll. (1957), pp 26-61.
- Britton, Max E., Vegetation of the Arctic Tundra (Corvallis: Ore. St. Univ. Press, 1966), 64 pp.
- Brockman, C. F., Trees of North America (New York: Golden, 1968).
- Bromley, S. W., "The Original Forest Types of Southern New England," Ecol. Monogr., Vol 5 (1935), pp 61-89.
- Broun, Maurice, ed., Index to North American Ferns (Orleans, Mass.: Published by the compiler, 1938).
- Campbell, D. H., Mosses and Ferns (The Macmillan Company, 1928).
- Christensen, Clyde M., Common Edible Mushrooms (Minneapolis: Univ. Minnesota, 1943).
- Christensen, Clyde M., Common Fleshy Fungi (Minneapolis: Burgess Publ. Co., 1955).
- Clausen, Robert T., Sedum of North America North of the Mexican Plateau (Ithaca, N.Y.: Cornell Univ. Press, 1975), 742 pp.
- Clute, Willard Nelson, The Fern Allies of North America North of Mexico (New York: Frederick A. Stokes Co., 1905).
- Clute, Willard Nelson, The Fern Allies of Western America North of Mexico and New York (New York: F. A. Stokes and Company, 1905).

- Clute, Willard N., Our Ferns: Their Haunts, Habits and Folklore, 2nd ed. (New York: Frederick A. Stokes Co., 1938).
- Cobb, Boughton, A Field Guide to the Ferns and Their Related Families of Northeastern and Central North America (Boston: Houghton Mifflin, 1956), 281 pp.
- Coker, William C. and Henry R. Totten, Trees of the Southeastern States (Univ. North Carolina Press, 1945), 419 pp.
- Conard, H. S., How to Know the Mosses and Liverworts (Dubuque, Iowa: William C. Brown Co., 1956).
- Cooper, W. S., The Strand and Drive Flora of the Pacific Coast of North America, in Essays in Geobotany, ed. T. H. Goodspeed (Berkeley: Univ. Calif Press, 1936), pp 141-187.
- Copeland, Edwin Bingham, Genera Filicum, the Genera of Ferns. (Waltham, Mass.: Chronica Botanica Co., 1947).
- Correll, D. S., Ferns and Fern Allies of Texas (Contribution of Texas Research Foundation, 1956).
- Craighead, John J., Frank C. Craighead, Jr., and Ray J. Davis, A Field Guide to Rocky Mountain Wildflowers (Boston: Houghton Mifflin, 1963).
- Cuthbert, M., How to Know the Spring Wildflowers; How to Know the Fall Wildflowers (Dubuque, Iowa: Brown, 1943, 1948).
- Dana, Mrs. William Starr, How to Know the Wild Flowers (1913; rpt. New York: Dover, 1963).
- Daubenmire, R. and J. B. Daubenmire, Forest Vegetation of Eastern Washington and Northern Idaho, Wash. Agric. Exp. Stn. Tech. Bull. 60 (1968), 104 pp.
- Dawson, E. Y., How to Know the Cacti (Dubuque, Iowa: Brown, 1963).
- Detling, L. E., "The Flora of the Columbia River Gorge," Northwest Sci., Vol 40 (1966), pp 133-137.
- Dodge, Raynal, The Ferns and Fern Allies of New England (Binghamton, N.Y.: W. N. Clute & Co., 1896).
- Dorman, Caroline, Flowers Native to the Deep South (Baton Rouge, La.: Claitors Book Store, 1958).
- Duncan, Wilbur H. and Leonard E. Foote. Wildflowers of the Southeastern United States (Athens: Univ. Georgia Press, 1975), 296 pp.

- Durand, Herbert, Wild Flowers and Ferns in Their Homes and in Our Gardens (New York: G. P. Putnam's Sons, 1925).
- Eastman, Helen, New England Ferns and Their Common Allies (Boston: Houghton Mifflin & Co., 1904).
- Eaton, D. C., Ferns of North America 2 Vols (Salem, Mass.: S. E. Cassino, 1879-80).
- Eyles, Don E. and J. Lynne Robertson, Jr., A Guide and Key to the Aquatic Plants of the Southeastern U.S., U.S. Fish & Wildl. Serv. Cir. No. 158 (1963), 151 pp.
- Fassett, N. C., A Manual of Aquatic Plants (New York: McGraw-Hill, 1940).
- Fassett, N. C., A Manual of Aquatic Plants (Madison: Univ. Wisc. Press, 1957), 405 pp.
- Fernald, M. L., Gray's Manual of Botany, 8th ed. (New York: American Book Co., 1950), 1632 pp.
- Fink, B., The Lichen Flora of the United States (Ann Arbor, Mich.: Univ. Michigan Press, 1949).
- Franklin, J. F. and C. T. Dyrness, Natural Vegetation of Oregon and Washington, USDA For. Serv. Gen. Tech. Rept. PNW-8 (1973), 417 pp.
- Franklin, J. F. and C. T. Dyrness, Vegetation of Oregon and Washington, U.S. For. Serv. Res. Pap. PNW-80 (1973), 216 pp.
- Frye, T. and L. Clark, Hepaticae of North America, 2 Vols (Seattle: University of Washington Press, 1937-1947).
- Gilkey, Helen, Handbook of Northwestern Plants (Oreg. St. Univ. Bookstore, 1973).
- Gleason, H. A., The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada, 3 Vols (New York: Botanical Garden, 1952).
- Gleason, Henry A. and Arthur Cronquist, Manual of Vascular Plants of Northeastern United States and Adjacent Canada (Princeton, N.J.: D. Van Nostrand Co., Inc., 1963).
- Graham, V. O., Mushrooms of the Great Lakes Region (reprint, New York: Dover, 1970).

- Graham, Verne O., Mushrooms of the Great Lakes Region (Chicago Acad. Sci. and Chic. Nat. Hist. Mus., 1944).
- Graves, A. H., Illustrated Guide to Trees and Shrubs (New York: Harper & Row, 1956).
- Grimm, W. C., Recognizing Trees (Harrisburg Pa.: Stackpole, 1960).
- Grimm, W. C., How to Recognize Shrubs (Recognizing Native Shrubs) (Harrisburg, Pa.: Stackpole; New York: Castle, 1966).
- Groot, A. J., Mosses With a Hand Lens, 4th ed. (published by the author, 1 Vine Street, New Brighton, Staten Island, N.Y., 1947).
- Hale, M., Lichen Handbook (Washington, D.C.: Smithsonian Institution, 1961).
- Hale, M. E., How to Know the Lichens (Dubuque, Iowa: Brown, 1969).
- Harlow, William M., Fruit Key and Twig Key to Trees and Shrubs (New York: Dover, 1959).
- Harlow, William M., Trees of the Eastern and Central United States and Canada (New York: Dover Publs., Inc., 1957).
- Harrar, Ellwood S. and J. George Harrar, Guide to Southern Trees (New York: Dover Publs., Inc., 1946).
- Hayes, Doris W., "Key to Important Woody Plants of Eastern Oregon and Washington," U.S.D.A. Handbook 148 (1960), Supt. of Documents, Washington, D.C.
- Hitchcock, A. S., Manual of the Grasses of the United States, 2nd ed. rev. by Agnes Chase, U.S. Dept. Agric., Misc. Publ. No. 200 (1951), pp 1-1051.
- Hitchcock, C. L. and A. Cronquist, Flora of the Pacific Northwest (Seattle: Univ. Wash. Press, 1973), 730 pp.
- Hitchcock, C. L., A Cronquist, M. Ownbey and J. W. Thompson, Vascular Plants of the Pacific Northwest, 5 vols. (Seattle: Univ. Wash. Press, 1955).
- Hotchkiss, Neil, Pondweeds and Pond Weedlike Plants of Eastern North America. U.S. Fish and Wildl. Serv. Cir. No. 187 (1964), 30 pp.
- Ingram, W. M. and G. W. Presscott, "Toxic Freshwater Algae," Amer. Midl. Natur., Vol 52 (1954), pp 75-87.
- Jaques, H. E., How to Know the Trees, rev. ed. (Dubuque, Iowa: Brown, 1946).

- Jaques, H. E., How to Know the Weeds (Dubuque, Iowa: Brown, 1972).
- Jaques, H. E., Plant Families, How to Know Them (Dubuque, Iowa: Brown, 1949).
- Kauffman, C. H., The Gilled Mushrooms (Agaricaceae) of Michigan and the Great Lakes Region, 2 vols. (reprint of 1918 ed., New York: Dover, 1971).
- Keeler, H., Our Northern Shrubs and How To Identify Them (reprint, New York: Dover, 1969).
- Kleijn, H., Mushrooms and Other Fungi (New York: Doubleday & Company, 1962).
- Krieger, Louis C., The Mushroom Handbook (New York: Macmillan Co., 1936).
- Kuchler, A. W., Map and Accompanying Manual, Potential Natural Vegetation of the Conterminous United States, Amer. Geogr. Soc., Spec. Publ. No. 36 (1964), 116 pp.
- Lawrence, George H. M., Taxonomy of Vascular Plants (New York: Macmillan Co., 1951).
- Lawton, E., Moss Flora of the Pacific Northwest, Hattori Bot. Lab., Japan, (1971), 362 pp.
- Lemmon, Robert S. and Charles C. Johnson, Wild Flowers of North America in Full Color (Hanover House, 1961).
- Little, E. I., Jr., Atlas of United States Trees: Vol 1, Conifers and Important Hardwoods, USDA Misc. Publ. No. 1146 (1971).
- Lloyd, R. M. and R. S. Mitchell, A Flora of the White Mts., California and Nevada (Berkeley: Univ. Calif. Press, 1973), 202 pp.
- Lopinot, A. C., Aquatic Weeds, Their Identification and Methods of Control, Dept. Conserv. Div. Fish., Springfield, Illinois, Fish Bull No. 4 (1971), 54 pp.
- Matthews, F. S., ed. by Norman Taylor, Field Book of American Wildflowers, rev. ed. (New York: Putnam, 1955).
- McKenny, Margaret and D. E. Stuntz, The Savory Wild Mushroom (Seattle: Univ. Wash., 1962).
- McMinn, H. E. and E. Maino, An Illustrated Manual of Pacific Coast Trees (Berkeley: University of California Press, 1946).

- Mooney, H. A. and W. D. Billings, "The Ecology of Arctic and Alpine Plants," Biol. Rev. (Camb.), Vol 43 (1968), pp 481-530.
- Muenschner, W. C., Aquatic Plants of the United States (Ithaca, N.Y.: Comstock Publ. Co., 1944), 374 pp.
- Muenschner, W. C. L., Weeds, 2nd ed. (New York: MacMillan Co., 1955).
- New York Botanical Garden, North American Flowers (Lancaster, Pa: New Era Printing Company, 1942).
- Niehaus, T. F., Sierra Wildflowers, Mt. Lassen to Kern Canyon, Calif. Nat. Hist. Guide 32 (Berkeley: Univ. Calif. Press, 1974), 233 pp.
- Parsons, F. T., How to Know the Ferns: A Guide to Names, Haunts, and Habits (reprint, New York: Dover, 1961).
- Patrick, R. and C. W. Reimer, The Diatoms of the U.S. Exclusive of Alaska and Hawaii, Vol 1 (Philadelphia: Acad. Nat. Sci., 1966).
- Patrick, R. and C. W. Reimer, The Diatoms of the United States, Vol 2, Acad. Nat. Sci. Phila., Monogr. No. 13 (1975).
- Peattie, D. C., Natural History of Western Trees (Boston: Houghton Mifflin, 1953).
- Peattie, D. C., Natural History of Trees of Eastern and Central North America (Boston: Houghton Mifflin, 1966).
- Peterson, Roger T. and Margaret McKenny, A Field Guide to Wildflowers of Northeastern and North-Central North America (Boston: Houghton Mifflin, 1968).
- Petrides, George A., A Field Guide to Trees and Shrubs, 2nd ed. (Boston: Houghton Mifflin Co., 1972), 428 pp.
- Pohl, Richard W., The Grasses (Dubuque, Iowa: William C. Brown Co., Publ., 1968), 244 pp.
- Porter, C. L., Taxonomy of Flowering Plants (San Francisco: W. H. Freeman and Co., 1959), 452 pp.
- Prescott, G. W., Algae of Western Great Lakes Area, Exclusive of the Desmids and Diatoms, 1st ed., Cranbrook Inst. Sci., No. 31 (1951), 949 pp.
- Prescott, G. W., Algae of the Western Great Lakes Area (Dubuque, Iowa: William C. Brown Co., 1962).
- Prescott, G. W., How to Know the Fresh-water Algae (Dubuque, Iowa: William C. Brown Co., 1954).

- Prescott, G. W., How to Know the Fresh Water Algae (Dubuque, Iowa: Brown, 1964).
- Quarterman, E. and C. Keever, "Southern Mixed Hardwood Forest: Climax in the Southeastern Coastal Plain, U.S.A.," Ecol. Monogr., Vol 32 (1962), pp 167-185.
- Radford, A. E., H. E. Ahles and C. R. Bell, Manual of the Vascular Flora of the Carolinas (Chapel Hill: Univ. North Carolina Press, 1968), 1183 pp.
- Ramsbottom, J., Mushrooms and Toadstools (New York: William Collins Sons & Co., Ltd., 1953).
- Rickett, H. W., New Field Book of American Wildflowers (New York: Putnam, 1963).
- Rickett, Harold W., Wild Flowers of the United States, Vol I: The Northeastern States (Houghton-Mifflin, 1966).
- Rickett, H. W., Wild Flowers of the United States, Vol 1 (New York: McGraw-Hill, 1966).
- Rickett, H. W., Wildflowers of the United States, Vol II, The Southeastern States; Vol III, Texas (New York: McGraw-Hill, 1968).
- Roberts, Edith A. and Julia R. Lawrence, American Ferns: How to Know, Grow and Use Them (New York: Macmillan Co., 1935).
- Rydberg, P. A., Flora of the Rocky Mountains and Adjacent Plains (1922; rept. New York: Hafner, 1969).
- Sargent, C. S., Manual of Trees of North America, reprint, 2 Vols. (New York: Dover, 1922).
- Shanks, R. E., Summer Key to Tennessee Trees, 2 Vols. (University of Tennessee Press, 1963, 1968).
- Shaver, J. M., Ferns of the Eastern Central States, With Special Reference to Tennessee (1954, rpt. New York: Dover, 1970).
- Shreve, Forrest, "The Plant Life of the Sonoran Desert," Sci. Mo., Vol 42 (1936), pp 195-213.
- Shreve, Forrest, "The Desert Vegetation of North America," Bot. Rev., Vol 8 (1942), pp 195-246.

AD-A086 526

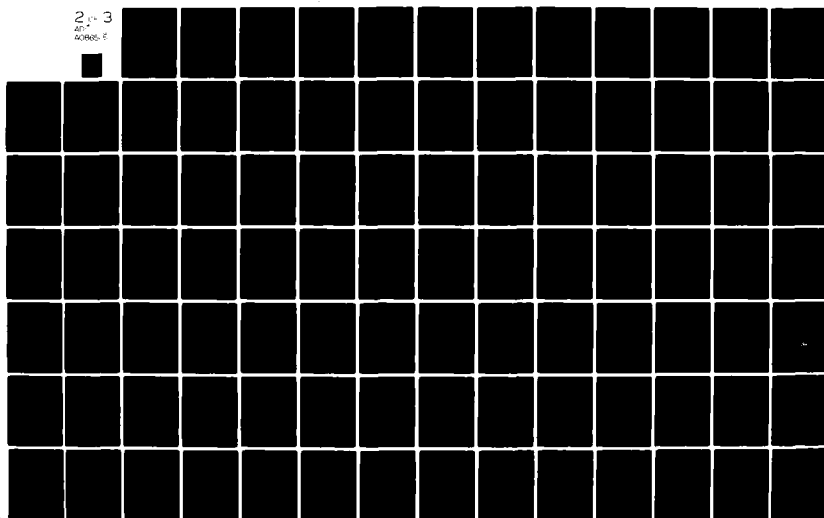
CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/6 6/6
GUIDELINES FOR TERRESTRIAL ECOSYSTEM SURVEY.(U):
MAY 80 W D SEVERINGHAUS

UNCLASSIFIED

CERL-TR-N-89

NL

2 of 3
407
50865-1



- Shreve, Forrest and I. L. Wiggins, Vegetation and Flora of the Sonoran Desert, Vol I: Vegetation of the Sonoran Desert, Carnegie Inst. Wash. Publ. 591 (1951), 192 pp.
- Small, John K., Manual of the Southeastern Flora, 2 Vols. (New York: Hafner Publ. Co., 1972), 1554 pp.
- Smith, Alexander H., The Mushroom Hunter's Field Guide Revised and Enlarged (Ann Arbor: Univ. Michigan Press, 1964).
- Smith, Gladys L., "A Flora of the Tahoe Basin and Neighboring Areas," Wasmann J. Biol., Vol 31, No. 1 (1973), pp 231.
- Smith, G. M., Freshwater Algae of the United States, 2nd ed. (New York: McGraw-Hill, 1950), 716 pp.
- Stephens, H. A., Woody Plants of the North Central Plains (Lawrence: Univ. Kan. Press, 1974), 530 pp.
- Stewart, Albert N., LaRea J. Dennis and Helen M. Gilkey, Aquatic Plants of the Pacific Northwest (Corvallis: Oregon State Univ. Press, 1956).
- Thomas, W. C., Field Book of Common Mushrooms (New York: Putnam, 1936).
- Trelease, W., Winter Botany: An Identification Guide to Native Trees and Shrubs (reprint, New York: Dover, 1967).
- U.S.D.A., Seeds of Woody Plants in the United States, U.S.D.A. Ag. Handbook No. 450 (1974), 883 pp.
- Vines, R. A., Trees, Shrubs and Woody Vines of the Southwest (Austin: University of Texas Press, 1963).
- Waters, Campbell E., Ferns: A Manual for the Northeastern States with Analytical Keys Based on the Stalks and on the Fructification (New York: Henry Holt & Co., 1903).
- Weber, W. A., Rocky Mountain Flora (Boulder: Univ. Colorado Press, 1967), 437 pp.
- Wherry, E. T., Guide to Eastern Ferns, 2d ed. (Lancaster, Pa.: Science Press, 1942).
- Wherry, E. T., The Wildflower Guide (New York: Doubleday, 1948).
- Wherry, Edgar T., The Fern Guide: Northeastern and Midland U.S. and Adjacent Canada (New York: Doubleday & Co., Inc., 1961).

Whittaker, Robert H., "Vegetation of the Great Smoky Mountains,"
Ecol. Mono., Vol 26 (1956), pp 1-80.

Whittaker, Robert H., "Vegetation of the Siskiyou Mountains, Oregon
and California," Ecol. Mono., Vol 30 (1960), pp 279-338.

Woodbury, A. M., "Distribution of Pigmy Conifers in Utah and North-
eastern Arizona," Ecology, Vol 28 (1947), pp 113-126.

Wiley, Farida A., Ferns of Northeastern United States (New York:
American Museum of Natural History, 1936, revised 1948).

3. Biota of the United States

Alabama

Archer, A. F., "The Theridiidae or Comb-footed Spiders of Alabama,"
Alabama Mus. Nat. Hist., Paper 22 (1946), pp 1-67.

Chermock, Ralph L., "A Key to the Amphibians and Reptiles of Alabama,"
University, Ala.: Geol. Survey of Alabama, Museum Paper No. 33
(1952).

Haltom, William L., "Alabama Reptiles," Ala. Univ. Mus. Nat.
Hist., Paper 11 (1931), 145 pp.

Harper, R. M., "The Forest Resources of Alabama," Am. For., Vol
19 (1913), pp 657-670.

Hill, E. R., "The Cottontail Rabbit in Alabama," Alabama Coop. Wildlife
Res. Unit Bull., Vol 440 (1972), pp 1-103.

Holliman, D. C., The Mammals of Alabama, Unpublished Ph.D. Dissertation,
Univ. of Alabama (1963), 285 pp.

Howell, A. H., "A Biological Survey of Alabama," N. Amer. Fauna,
Vol 45 (1921), pp 1-88.

Ianhof, Thomas A., Alabama Birds (Univ. Ala. Press, 1976).

Mount, Robert H., Reptiles and Amphibians of Alabama (Auburn:
Auburn Univ., Agric. Experiment Station, 1975).

Alaska

Bailey, Alfred M., "The Birds of Arctic Alaska," Colorado Mus. Nat.
Hist. Pop. Ser., Vol 8 (1948), pp 1-317.

Bee, J. W., and E. R. Hall, "Mammals of Northern Alaska," Univ. Kansas
Publ., Mus. Nat. Hist., Misc. Publ., No 8 (1956), 309 pp.

Bee, James W., "Birds Found on the Arctic Slope of Northern Alaska,"
Univ. Kansas Publ., 10 (1958), pp 163-211.

Cahalane, V. H., "A Biological Survey of Katmai National Monument,"
Smithsonian Misc. Publ., Vol 138, No 5 (1959).

Dufresne, Frank, Alaska's Animals and Fishes (New York: Barnes, 1946).

- Hansen, H. P., Arctic Biology, 11 papers present at Biology Colloquium at Oregon State Univ., 2nd Ed. (Corvallis: Oregon State Univ. Press, 1957, 1965).
- Hodge, Robert P., "Amphibians and Reptiles in Alaska, the Yukon and Northwest Territories," Alaska Northwest (1976).
- Johansen, Frits, "The Crustacean Life of Some Arctic Lagoons, Lakes, and Ponds," Rept. Can. Arctic Exp., 1913-1918, Vol 7 (1922), pp 1-31.
- Kenk, Roman, "The Fresh-Water Triclad (Turbellaria) of Alaska," Proc. U.S. Nat. Mus., Vol 103 (1953), pp 163-186.
- Logier, E. B. S., and G. C. Toner, "Check List of the Amphibians and Reptiles of Canada and Alaska," Toronto: Contrib. of the Royal Ontario Mus. of Zool. and Palaeon., No. 53 (Toronto: 1961).
- Manville, R. H. and S. P. Young, Distribution of Alaskan Mammals, Washington, D.C.: Bur. Sport Fish and Wildl., Cir 211 (1965).
- McPhail, J. D. and C. C. Lindsey, "Freshwater Fishes of Northwestern Canada and Alaska," Fish. Res. Board. Can. Bull., Vol 173 (1970), 381 pp.
- Morrow, James E., "Illustrated Keys to the Freshwater Fishes of Alaska," Alaska Northwest (1974).
- Murie, O. J., "Fauna of the Aleutian Islands and Alaska Peninsula," N. Amer. Fauna, No 61 (1951).
- Pitelka, Frank A., "Numbers, Breeding Schedule, and Territoriality in Pectoral Sandpipers of Northern Alaska," Condor, Vol 61 (1959), pp 233-264.
- Scott, W. B., "A Checklist of the Freshwater Fishes of Canada and Alaska" (Royal Ontario Mus.: 1958), 30 pp.
- Vierick, L. A. and E. L. Little, Alaska Trees and Shrubs, Ag. Handbook No. 410 (Washington, D.C.: U.S. Dept. of Ag., 1972).
- Vierick, L. A., and E. L. Little, Jr., Atlas of United States Trees, Vol 2: Alaska Trees and Common Shrubs (Washington, D.C.: U.S. Dept. of Ag. For. Serv. Misc. Publ. 1293, 1975).
- Walker, E. M., The Odonata of Canada and Alaska, Vol 1 (Toronto: Univ. Toronto Press, 1953), 286 pp.

Walker, E. M. and Philip S. Corbert, The Odonata of Canada and Alaska, Vol 3 (Toronto: Univ. Toronto Press, 1975), 307 pp.

Whitehouse, F. C., "Catalogue of the Odonata of Canada, Newfoundland, and Alaska," Trans. Roy. Can. Inst., Vol 27 (1958), pp 3-56.

Wiggins, I. L. and J. H. Thomas, Flora of the Alaskan Arctic Slope (Toronto: Univ. of Toronto Press, 1962).

Wilimovsky, Norman J., "List of the Fishes of Alaska," Stanford Ichthyological Bull., Vol 4, No. 5 (1954), pp 279-294.

Arizona

Cockrum, E. Lendell, The Mammals of Arizona, Their Taxonomy and Distribution (Tucson: Univ. Ariz. Press, 1960).

Hoffmeister, Donald F., Mammals of the Arizona Strip Including Grand Canyon National Monument, Museum of Northern Arizona, Technical Series No. 11 (1971).

Hoffmeister, D. F. and W. W. Goodpaster, "The Mammals of the Huachuca Mountains, Southeastern Arizona," Illinois Biol. Monogr. Vol 24 (1954), pp 1-152.

Hury, Laurence M., "A Vertebrate Fauna Survey of the Oregon Pipe Cactus National Monument, Arizona," Trans. San Diego Soc. Nat. Hist., Vol 9 (1942), pp 355-375.

Kearney, T. H. and R. H. Peebles, Arizona Flora, (Berkeley: Univ. Calif. Press, 1960), 1085 pp.

Lanning, Dirk, "Density and Movements of the Coati in Arizona," J. of Mammalogy, Vol 57, No. 3 (August 1976).

Lowe, C. H., ed., Vertebrates of Arizona (Tucson: Univ. of Ariz. Press, 1967).

Minckley, W. L., Fishes of Arizona (Phoenix: Sims Printing Co., 1973), 293 pp.

Nelson, Dick and Sharon Nelson. Easy Field Guide to Common Desert Birds of Arizona (Tucson: Tecolote Press, 1976).

Phillips, Allen, et al., The Birds of Arizona (Tucson: Univ. Ariz. Press, 1964).

Scott, V. E. and Boeker, E. L., "An Evaluation of Wild Turkey Call Counts in Arizona," Journal of Wildlife Management, Vol 36, No. 2 (1972), pp 628-630.

Arkansas

Baker, R. J. and C. M. Ward, "Distribution of Bats in Southeastern Arkansas," Jour. Mammal, Vol 48 (1967), pp 130-132.

Buchanan, T. M., Key to the Fishes of Arkansas, (Little Rock: Arkansas Game and Fish Commission, 1973), 68 pp.

Dowling, Herndon G., "A Review of the Amphibians and Reptiles of Arkansas," Fayetteville: U. of Arkansas Mus. Occasional Papers, No. 3 (1957).

Sealander, J. A., Jr., "A Provisional Checklist and Key to the Mammals of Arkansas (With Annotations), Amer. Mid. Nat., Vol 56 (1956), pp 257-296.

Sealander, John A., Philip S. Gipson, and J. Maxine Hite Manley, "The Distribution of the Prairie Vole (Microtus ochrogaster) and the Southern Boy Learning (Synaptomys Cooperi) in Arkansas," Texas J. Sci., Vol 26, Nos. 3 and 4 (1975), pp 421-430.

Smith, Kimberly G., "Distribution of Summer Birds Along a Forest Moisture Gradient in an Ozark Watershed," Ecology, Vol 58, No. 4 (1977).

California

Beetle, A. A., "Distribution of the Native Grasses of California," Hilgardia, Vol 17 (1947), pp 309-357.

Biswell, H. H., "Ecology of California Grasslands," J. Range Manage., Vol 9 (1956), pp 19-24.

Brown, Vinson and Henry Weston, Jr., Handbook of California Birds, (Naturegraph Co., 1973), 156 pp.

Case, Ted, "Species Numbers, Density Compensation and Colonizing Ability of Lizards on Islands in the Gulf of California," Ecology, Vol 56, No. 1 (1975).

Crampton, Beecher, Grasses in California: Calif. Nat. Hist. Guide 33 (Berkeley: Univ. Calif. Press, 1974), 178 pp.

- Critchfield, W. B., "Profiles of California Vegetation," U.S. For. Serv. Res. Paper, PSW No. 76 (1971), 54 pp.
- Culbertson, Alexander E., Large Wild Mammals of California (Sacramento: California State Department of Education, 1938).
- Dawson, W. L., The Birds of California (San Diego: South Moulton Co., 1923).
- Ferlatte, W. J., A Flora of the Trinity Alps of Northern California (Berkeley: Univ. Calif. Press, 1974), 206 pp.
- Griffin, J. R. and W. B. Critchfield, "The Distribution of Forest Trees in California," U.S. For. Serv., Pacif. S.W. For. and Range Exp. Stn. Res. Paper, PSW-82 (1972), 14 pp.
- Grinnell, J., H. C. Bryant, and T. I. Storer. The Game Birds of California, (Berkeley: Univ. Calif. Press, 1918).
- Grinnell, J., J. S. Dixon, and J. M. Linodale, Fur-bearing Mammals of California, 2 Vols (Berkeley: Univ. Calif. Press, 1937), 777 pp.
- Grinnell, J. and A. H. Miller, "The Distribution of the Birds of California," Pacific Coast Avifauna, No. 27 (1944).
- Hansen, H. J., On Some California Schizopoda (Berkeley: Univ. of Calif. Press, 1913).
- Hughes, B. O. and Duncan Dunning, "Pine Forests of California" in The Yearbook of Agriculture (Washington, D.C.: U.S. Dept. Ag., 1949), pp 352-358.
- Ingles, Lloyd G., Small Wild Mammals of California (Sacramento: Calif. State Dept. of Education, 1936).
- Ingles, Lloyd Glenn, "Nesting Birds of the Willow-Cottonwood Community in California," Auk, Vol 67 (1950), pp 325-332.
- Ingles, Lloyd G., Mammals of California (Stanford, Calif: Stanford Univ. Press, 1947).
- Ingles, L. G., Mammals of California and its Coastal Waters, 2nd ed. (Stanford, Calif: Stanford Univ. Press, 1954).
- Jaeger, Edmund C., The California Deserts, (Stanford, Calif: Stanford Univ. Press, 1955), pp 1-211.

- Jepson, W. L., A Flora of California, Vol 3 (Univ. Calif., Berkeley: Assoc. Students Store, 1939).
- Lederer, Roger J., "Winter Territoriality and Foraging Behavior of the Townsends Solitaire," The Amer. Midland Naturalist Vol 97, No. 1 (1977).
- McCloskey, R. T., "Temporal Changes in Population and Species Diversity in a California Rodent Community," J. of Mammalogy, Vol 53, No. 4 (1972).
- McNaughton, S. J., "Structure and Function in California Grasslands," Ecology, Vol 49, No. 5 (1968).
- Major, J. and M. G. Barbour, eds., Terrestrial Vegetation of California (New York: Wiley Interscience, 1977), 1002 pp.
- Miller, A. H. "An Analysis of the Distribution of the Birds of California," Univ. Calif. Publ., Zool., Vol 50 (1951), pp 531-644.
- Moyle, Peter B., Inland Fishes of California (Berkeley: Univ. Calif. Press, 1976), 405 pp.
- Munz, P. A., A Flora of Southern California (Berkeley: Univ. Calif. Press, 1974), 1086 pp.
- Munz, P. A. and D. D. Keck, A California Flora (Berkeley: Univ. Calif. Press, 1963), 1681 pp.
- Munz, P. A. and D. D. Keck, "California Plant Community," Aliso, Vol 2 (1949), pp 87-105.
- Murphy, G., "A Key to the Fishes of the Sacramento-San Joaquin Basin," Calif. Fish and Game, Vol 27, No. 3 (1941), pp 165-171. A key covering most of the fishes of California.
- Ornduff, Robert, Introduction to California Plantlife (Berkeley: Univ. Calif. Press, 1974), 152 pp.
- Orr, R. T., "The Rabbits of California," Occ. Pap. Calif. Acad. Sci., Vol 19 (1940), pp 1-207.
- Parish, S. B., "Vegetation of the Mohave and Colorado Deserts of Southern California," Ecology, Vol 11 (1930), pp 481-499.
- Parsons, M. E., The Wild Flowers of California (New York: Dover Publications, Inc., 1966).
- Peterson, P. V., Native Trees of the Sierra Nevada (University of Calif. Press, 1975).

- Schick, R. X., "The Crab Spiders of California (Araneida, Thomisidae)," Bull. Amer. Mus. Nat. Hist., Vol 129 (1965), pp 1-180.
- Small, A., The Birds of California (New York: Winchester Press, 1974), 310 pp.
- Stebbins, Robert C., Amphibians and Reptiles of California (Univ. Calif. Press, 1972).
- Usinger, R. L., Aquatic Insects of California (Berkeley: Univ. Calif. Press, 1956), 508 pp.
- Usinger, R. L., ed., Aquatic Insects of California, with Keys to North American Genera and California Species (Berkeley: Univ. Calif. Press, 1971).
- Vaughan, Terry A., "Mammals of the San Gabriel Mountains of California," Univ. Kansas Publ., Mus. Nat. Hist., Vol 7, No. 9 (1954), pp 513-582.
- White, K. L., "All Field Successors on Hastings Reservation, California," Ecology, Vol 47 (1966), pp 865-868.
- White, K. L., "Native Bunchgrass (Stipa pulchra) on Hastings Reservation, California," Ecology, Vol 48 (1967), pp 949-955.
- Yeaton, Richard I., "An Ecological Analysis of Chaparral and Pine Forest Bud Communities on Santa Cruz Island and Mainland California," Ecology, Vol 55, No. 5 (1974).

Colorado

- Armstrong, D. M., "Distribution of Mammals in Colorado," Monogr. Mus. Nat. Hist. Univ. Kansas (1972), 415 pp.
- Bailey, A. M., and R. J. Niedrach, Birds of Colorado, Vol 1 (Denver: Mus. Natur. Hist., 1965).
- Bailey, Alfred M., The Red Crossbills of Colorado (Denver Mus. Natur. Hist., 1953).
- Beckman, W. C., Guide to the Fishes of Colorado (Boulder: Univ. Colo. Mus., 1963), 110 pp.
- Brown, F. M., D. Eff, and B. Rotger, Colorado Butterflies (Denver: Denver Mus. Nat. Hist., 1954).
- Culver, D. C., "A Niche Analysis of Colorado Ants," Ecology, 53 (1972), pp 126-131.

Durrell, L. W., R. Jensen, and B. Klinger, Poisonous and Injurious Plants in Colorado (Fort Collins: Colo. Agric. Exp. Stu. Bull. 412 A), 88 pp.

Finley, R. B., Jr., "The Woodrats of Colorado: Distribution and Ecology," Univ. Kansas Publ., Mus. Nat. Hist., Vol 10 (1958), pp 213-552.

Gregg, R. E., The Ants of Colorado (Boulder: Univ. Colo. Press, 1963), 792 pp.

Grinnell, Joseph, An Account of the Mammals and Birds of the Lower Colorado Valley With Special Reference to the Distributional Problem Presented (Univ. Calif. Press, 1914).

Harrington, H. D., Manual of the Plants of Colorado (Denver: Sage Books, 1954), 666 pp.

Holm, Theodore, "The Vegetation of the Alpine Region of the Rocky Mountains in Colorado," Nat. Acad. Sci. Mem., Vol 19, No. 3 (1927), pp 1-45.

Langenheim, J. H., "Vegetation and Environmental Patterns in the Crested Butte Area, Gunnison County, Colorado," Ecol. Monogr., Vol 32 (1962), pp 249-285.

Lechleitner, R. R., Wild Mammals of Colorado (Boulder: Pruett, 1969).

Ramaley, F., Colorado Plant Life (Boulder: Univ. Colo. Press, 1927).

Rodeck, H. G., Guide to the Mammals of Colorado, Univ. Colo. Mus., Leaflet No. 10, 1952.

Warren, E. R., Mammals of Colorado (New York: Putnam, 1910), 300 pp.

Warren, E. R., The Mammals of Colorado, 2nd ed., revised (Norman: Univ. Oklahoma Press, 1942), 330 pp.

Warren, Edward R., The Mammals of Colorado, Their Habits and Distribution (Norman: Univ. of Oklahoma Press, 1942).

Connecticut

Bailey, Joseph R. and James A. Oliver, "The Fishes of the Connecticut Watershed," in Biol. Surv. of Conn. Watershed, N. H. Fish and Game Dept., Surv. Rept. No. 4 (1939), pp 150-189.

Babbitt, Lewis Hall, The Amphibia of Connecticut, State of Connecticut, Geol. and Nat. Hist. Survey Bull. No. 57 (1937).

Goodwin, G. G., The Mammals of Connecticut, State of Connecticut, Geol. and Nat. Hist. Survey Bull. No. 53 (1935), pp. 1-221.

Graves, Charles Burr, and others, Catalogue of the Flowering Plants and Ferns of Connecticut, State of Connecticut, State Geol. and Nat. Hist. Survey Bull. No. 14 and Supplement No. 48 of 1930.

Kaston, B. J., Spiders of Connecticut, State of Connecticut Geol. Nat. Hist. Survey Bull. No. 70 (1948), 874 pp.

Lamson, George Herbert, The Reptiles of Connecticut, State Geol. and Nat. Hist. Survey Bull. No. 54 (1935).

Nichols, G. E., "The Vegetation of Connecticut, II: Virgin Forests," Torrey, Vol 13 (1913), pp. 199-215.

Nichols, G. E., "The Vegetation of Connecticut, III: Plant Societies on Uplands," Torrey, Vol 14 (1914), pp. 167-194.

Peterson, Richard C., Connecticut's Venomous Snakes, State Geol. and Nat. Hist. Survey Bull. No. 103 (1970).

Whitworth, W. R., P. L. Berrien, and W. T. Keller, Freshwater Fishes of Connecticut, State Geol. and Nat. Hist. Surv. of Connecticut Bull. 101 (1968), 134 pp.

Delaware

Conant, Roger, An Annotated Check List of the Amphibians and Reptiles of the Del-Mar-Va Peninsula (Wilmington: Soc. of Nat. Hist. of Delaware, 1945).

Reed, Clyde F., The Ferns and Fern-Allies of Maryland and Delaware, Including District of Columbia (Baltimore: Reed Herbarium, 1953).

Florida

Allyn, Rube, Florida Fishes (Great Outdoors, 1969).

Bailey, R. M., and C. L. Hubbs, "The Black Basses of Florida With Description of a New Species," Misc. Publ. Mus. Zool., Univ. Mich. Vol. 516 (1949), pp. 1-40.

Bigler, W. J., J. H. Jenkins, "Population Characteristics of Peromyscus gossypinus and Sigmodon hispidus in Tropical Hammocks of South Florida," J. of Mammology, Vol 56, No. 3 (1975).

- Brown, Larry N. and R. J. McGuire, "Field Ecology of the Exotic Mexican Red Bellied Squirrel in Florida," J. of Mammology, Vol 56, No. 2 (1975).
- Carr, Archie, A Contribution to the Herpetology of Florida, Gainesville: Univ. of Florida Publ., Vol. 3, No. 1 (1940).
- Carr, Archie and C. I. Goin, Guide to the Reptiles, Amphibians and Fresh-Water Fishes of Florida. (Gainesville: Univ. Florida Press, 1955), i-viii, 341 pp. Keys, ranges, and descriptions of fishes found in freshwaters of Florida with some illustrations.
- Craigread, Frank C., The Trees of South Florida (University of Miami Press, 1971).
- Davis, John H., Jr., "The Natural Features of Southern Florida, Especially the Vegetation and the Everglades," Florida Biol. Surv. Bull., Vol 25 (1940), pp 1-311.
- Duellman, W. E. and A. Schwartz, "Amphibians and Reptiles of Southern Florida," Bull. Fla. State. Mus., Vol 3 (1958), pp 181-324.
- Harlow, R. F. and F. K. Jones, Jr., "The White-Tailed Deer in Florida," Fla. Game Fresh Water Fish Comm. Tech. Bull., No. 9 (1965), 240 pp.
- Herring, J. L., "The Aquatic and Semiaquatic Hemiptera of Northern Florida, Part I: Gerridae," Fla. Entomol., Vol 83 (1950), pp 22-32.
- Hobbs, H. H., Jr., "The Cray Fishes of Florida," Univ. Fla. Publ. Biol. Sci., Vol 3 (1942), pp 1-179.
- Hubbs, C. L. and E. R. Allen, "Fishes of Silver Springs, Florida," Proc. Fla. Acad. Sci., Vol 6 (1944), pp 110-130.
- Johnson, R. I., "The Unionidae (Mollusca: Bivalvia) of Peninsular Florida," Bull. Fla. State Mus., Vol 16 (1972), pp 181-249.
- Kimball, C. P., The Lepidoptera of Florida (Gainesville: Fla. Dept. Agric., 1965), 363 pp.
- Kurz, H., "Florida Dunes and Scrub Vegetation and Geology," Fla. Geol. Surv. Bull., No. 23 (1942), 154 pp.
- Kurz, H., and R. K. Godfrey, Trees of Northern Florida (Gainesville: Univ. Fla. Press, 1962), 318 pp.
- Loveless, C. M., "A Study of the Vegetation of the Florida Everglades," Ecology, Vol 40 (1959), pp 1-9.

Monk, C. D., "Southern Mixed Hardwood Forest of North Central Florida," Ecol. Monogr., Vol 35 (1965), pp 335-354.

Monk, C. D., "Tree Species Diversity in the Eastern Deciduous Forest with Particular Reference to North Central Florida," Amer. Natur., Vol 101 (1967), pp 173-187.

Sherman, H. B., "A List of the Recent Land Mammals of Florida," Proc. Fla. Acad. Sci., Vol 1 (1936), pp 102-128.

Stevenson, Henry M., Vertebrates of Florida (Univ. of Florida Press, 1976).

Wilson, E. O., "The Ants of the Florida Keys," Breviora, Vol 210 (1964), pp 1-14.

Georgia

Bostick, P. E., "Vascular Plants of Panola Mountain, Georgia," Castanea, Vol 36 (1971), pp 194-209.

Burleigh, F. D., Georgia Birds (Norman: Univ. Okla. Press, 1958), 746 pp.

Dahlberg, M. D., "An Ecological Study of Georgia Coastal Fishes," U. S. Fish Wildl. Serv. Bull., Vol 70 (1972), pp 323-353.

Day, Frank P. and Carl D. Monk, "Vegetation Patterns on a Southern Appalachian Watershed," Ecology, Vol 55, No. 5 (1974).

Golley, Frank B., The Mammals of Georgia (Athens: Univ. Georgia Press, 1962), 218 pp.

Harper, Francis, "The Mammals of the Okefenokee Swamp Region of Georgia," Proc. Boston Soc. Nat. Hist., Vol 38, No. 7 (1927), pp 191-396.

Harper, Francis, "Mammal Notes From Randolph County, Georgia," Jour. Mammal., Vol 10 (1929), pp 84-85.

Harris, Lucien, Butterflies of Georgia (University of Oklahoma Press, 1972).

Lowe, J. I., "Breeding Density and Productivity of Mourning Doves on a Countrywide Basis in Georgia," Journal of Wildlife Management, Vol 20 (1956), pp 428-433.

Martof, Bernard S., Amphibians and Reptiles of Georgia, Univ. California Press, 1956), 94 pp.

McGowan, T. A., "The Call Count as a Census Method for Breeding Mourning Doves in Georgia," Journal of Wildlife Management, Vol 17 (1953), pp 437-445.

McVaugh, Rogers and Joseph H. Pyron, Ferns of Georgia (Athens, Ga.: University of Georgia Press, 1951).

Neill, W. T. "The Lizards of Georgia," Herpetologica, Vol 4 (1948), pp 153-158.

Hawaii

Amadon, D., "The Hawaiian Honeycreepers (Aves, Drepaniidae)," Bull. Amer. Mus. Nat. Hist., Vol 95 (1950), pp 151-262.

Amadon, D., "The Hawaiian Honeycreepers (Aves, Drepanididae)," Bull. Amer. Mus. Nat. Hist., Vol 100 (1950), pp 397-451.

Berger, A. J., Hawaiian Birdlife (Honolulu: Univ. Hawaii Press, 1972), 270 pp.

Brock, V. E., "The Introduction of Aquatic Animals into Hawaiian Waters," Int. Revue Ges. Hydrobiol., Vol 45, No 4 (1960), pp 463-480. A description of all the fishes introduced into Hawaii up to 1960.

Gosline, W. A. and V. E. Brock, Handbook of Hawaiian Fishes (Honolulu: Univ. Hawaii Press, 1960).

Hardy, D. E., Insects of Hawaii, Vol 12: Diptera Cyclorhapha II (Honolulu: Univ. Hawaii Press, 1965), pp 182-245.

Morita, Clyde M., Freshwater Fishing in Hawaii (Honolulu: Div. of Game and Fish, 1963), 20 pp. A popular account of the introduced game and pan fishes in Hawaii.

Munro, G. C., Birds of Hawaii (Honolulu: Tongg Publ. Co., 1944).

Zimmerman, Elwood C., Insects of Hawaii, I: Introduction (Honolulu: Univ. Hawaii Press, 1948), pp 1-206.

Idaho

Burleigh, Thomas D., Birds of Idaho (Caxton, 1972).

Chadwick, H. W. and P. D. Dalken, "Plant Succession on Dune Sands in Fremont County, Idaho," Ecology, Vol 46 (1965), pp 765-780.

Davis, W. D., The Recent Mammals of Idaho (Caldwell, Idaho: Caxton Printers, Ltd., 1939), pp 1-400.

Windward, A. H., Taxonomic and Ecological Relationships of the Big Sagebrush Complex in Idaho, Ph.D. Dissertation, Univ. of Idaho, Moscow, 80 pp.

Illinois

Baker, F. C., Fieldbook of Illinois Land Snails, Nat. Hist. Surv. Div. Illinois, Manual 2 (1939).

Batzli, George O., "Population Dynamics of the White-Footed Mouse in Flood Plain Once Upland Forests," Amer. Midl. Natur. Vol 97, No. 1 (1977), pp 18-32.

Britton, M. E., "A Catalogue of Illinois Algae," Northwestern Univ. Stud. Biol. Sci. Med., No 2 (1944), 177 pp.

Burks, B. D., "The Mayflies, or Ephemeroptera, of Illinois," Bull. Ill. Nat. Hist. Surv., Vol 26 (1953), pp 1-216.

Cagle, F. R., "Turtle Populations in Southern Illinois," Copeia (1942) pp 155-162.

Cagle, Fred R., Key to the Reptiles and Amphibians of Illinois. Contrib. No. 5, Mus. Natur. and Soc. Sci., S. Ill. Univ., Carbondale (1941), pp 1-10.

Cahn, A. R., The Turtles of Illinois, Ill. Biol. Monogr., Vol 16 (1937), pp 1-218.

Cole, L. C., "A Study of the Unprotozoa of an Illinois Woodland," Ecol. Monogr., Vol 16 (1946), pp 49-86.

DeLong, Dwight M., "The Leafhoppers, or Cicadellidae, of Illinois (Eurymelinae - Balcluthinae)," Bull. Ill. Natural Hist. Surv., Vol 24 (1948), pp 91-376.

Eifert, Virginia S., Exploring for Mushrooms, Ill. St. Mus., Story of Ill., No. 3 (1945), 47 pp.

Eifert, Virginia S., Flowers that Bloom in the Spring, Ill. St. Mus. Story of Ill., No. 4 (1947), 48 pp.

Eifert, Virginia S., Invitation to Birds, Ill. St. Mus., Story of Ill., No. 5 (1948) 64 pp.

Fawks, Elton, Bird Findings in Illinois (Downers Grove, IL:, The Illinois Audubon Society, 1975) 98 pp.

- Forbes, S. A., The Fishes of Illinois, Nat. Hist. Surv. Ill., Vol III, Lehtyology (1908), 357 pp.
- Forbes, Stephen A. and Robert E. Richardson, The Fishes of Illinois, Second Edit., Nat. Hist. Surv. Ill., Vol 3 (1920), cxxi, 357 pp. Atlas, 103 maps. Keys and descriptions of the fishes of Illinois with illustrations. Nomenclature not up to date.
- Frison, Theodore H., "The Stoneflies or Plecoptera of Illinois," Bull. Ill. Nat. Hist. Surv., Vol 20 (1935), pp 281-471.
- Goodnight, Clarence J., "A Key to the Adult Salamanders of Illinois," Ill. State Acad. Sci. Trans., Vol 30, No. 2 (1937), pp 300-302.
- Graber, R. R., J. W. Graber and E. L. Kink, "Illinois Birds: Tyrannidae," Illinois Nat. Hist. Surv. Biol. Notes, No. 86 (1974).
- Gregg, R. E., "Ants of the Chiago Region," Entomol. Soc. Amer., Vol 37 (1944), pp 447-480.
- Gregory, Tappan, "Mammals of the Chicago Region," Chic. Acad. Sci. Prog. Act., Vol 7, Nos. 2-3 (1936), pp 13-75.
- Hebard, Morgan, "The Dermaptera and Orthoptera of Illinois," Bull. Ill. Natural Hist. Surv., Vol 20 (1934), pp iv + 125-179.
- Hoffmeister, D. F. and Carl O. Mohr, Fieldbook of Illinois Mammals (New York: Dover Publ., Inc., 1972), 233 pp.
- Hottes, Frederick C., and Theodore H. Frison "The Plant Lice, or Aphididae, of Illinois," Bull. Ill. Natural Hist. Surv., Vol 19, (1931), pp 121-447.
- Johnston, V. R., "Breeding Birds of the Forest Edge in Illinois," Condor, Vol 49 (1947), pp 45-53.
- Jones, G. N., Flora of Illinois (Notre Dame, Indiana: The Univ. of Notre Dame Press, 1963).
- Jones, Geroge Neville, Flora of Illinois, Containing Keys for Identification of the Flowering Plants and Ferns, The American Midland Naturalist Monograph No. 5, 2nd ed., Notre Dame, Ind.: University of Notre Dame Press, 1950.
- Lord, R. D., Jr. "The Cottontail Rabbit in Illinois," Illinois Dept. Conserv. Tech. Bull. Vol 3 (1963).
- Lueth, Francis X., Manual of Illinois Snakes (Springfield: Ill. Dept. Conserv., 1941), 48 pp.

- Malloch, J. R., "The Chironomidae, or Midges, of Illinois, With Particular Reference to the Species Occurring in the Illinois River," Bull. Illinois State Lab. Nat. Hist., Vol 10 (1915), pp 217-542.
- Mohlenbrock, R. H., A Flora of Southern Illinois (Carbondale: Southern Illinois Univ. Press, 1959).
- Mohlenbrock, R. H., G. E. Dillard and Abney Thomas, "A Survey of Southern Illinois Aquatic Vascular Plants," The Ohio Jour. Sci., Vol 61, No. 5 (1961), pp 262-273.
- Mohlenbrock, R. H. and D. M. Ladd, Distribution of Illinois Vascular Plants (Carbondale: Southern Illinois Univ. Press, 1978), 282 pp.
- Necker, Walter L. and Donald M. Hatfield, "Mammals of Illinois," Chic. Acad. Sci. Bull., Vol 6, No. 3 (1941), pp 17-60.
- Parmalee, Paul W., Amphibians of Illinois, Ill. St. Mus., Story of Ill., No. 10 (1954), 38 pp.
- Pope, Clifford H., Amphibians and Reptiles of the Chicago Area (Chic. Nat. Hist. Mus. Press, 1944), 142 pp.
- Ross, H. H., "The Eaddis Flies, or Trichoptera, of Illinois," Bull. Ill. Nat. Hist. Surv., Vol 23 (1944), pp 1-326.
- Ross, H. H., "The Mosquitoes of Illinois (Diptera, Culicidae)," Bull. Illinois Nat. Hist. Surv., Vol 24 (1947), pp 1-96.
- Schmidt, Karl P., The Frogs and Toads of the Chicago Area, Field Mus. Nat. Hist., Zool. Leaf., 11 (1929), 15 pp.
- Schmidt, Karl P., The Salamanders of the Chicago Area, Field Mus. Nat. Hist. Zool. Leaf., 12 (1930), 16 pp.
- Smith, P. W., The Amphibians and Reptiles of Illinois, Ill. Nat. Hist. Surv. Bull., Vol 28 (1961), pp 1-298.
- Smith, P. W., The Fishes of Illinois (Urbana: Univ. Illinois Press, 1979), 314 pp.
- Smith, Philip W., "The Reptiles and Amphibian of Eastern Central Illinois," Bull. Chic. Acad. Sci., Vol 8, No. 2 (1947), pp 21-40.
- Stannard, Lewis J., Jr., "The Thrips, or Thysanoptera of Illinois," Bull. Ill. Natural Hist. Surv., Vol 29 (1968), pp vi + 215-552.
- Tiffany, L. H. and M. E. Britton, The Algae of Illinois (Chicago: Univ. Chicago Press, 1952), 407 pp.
- Voss, J. and U. S. Eifert, "Illinois Wild Flowers," Ill. St. Mus., Popular Sci. Ser., Vol 3 (1967).

- Webb, D. W., N. D. Penny and J. C. Marlin, "The Mecoptera or Scorpion Flies of Illinois," Bull. Ill. Nat. Hist. Surv., Vol 31, No. 7 (1975), pp 151-316.
- Winterringer, Glen S., "Wild Orchids of Illinois," Ill. Sta. Mus., Popular Sci. Ser., Vol 7 (1967).
- Winterringer, Glen S. and Alvin C. Lopinot, Aquatic Plants of Illinois, Dept. Reg. and Ed., Ill. State Mus. Div. and Dept. Conserv., Div. Fish (1966).
- Wright, A. Gilbert, Common Illinois Insects, Ill. St. Mus., Story of Ill., No. 8 (1951), 32 pp.
- Indiana*
- Blatchley, Willis S., An Illustrated and Descriptive Catalogue of the Coleoptera or Beetles (Exclusive of the Rhynchophora) Known to Occur in Indiana, (Indianapolis, Ind.: Nature Publishing Co., 1910).
- Christensen, G. R. and F. C. Harmston, "A Preliminary List of the Mosquitoes of Indiana," J. Econ. Entomol., 37 (1944), pp 110-111.
- Deam, C. C., Flora of Indiana (Indianapolis: Indiana Department of Conservation, Division of Forestry, 1940).
- Deay, H. O. and G. E. Gould, "The Hemiptera of Indiana, I: Family Gerridae," Amer. Midl. Nat., Vol 17 (1936), pp 753-769.
- Friesner, Ray C., Key to Genera of Indiana Ferns and Fern Allies, Butler University Botanical Studies, Vol 55-60, (1929), Indianapolis.
- Gerking, Shelby D., "The Distribution of the Fishes of Indiana," Inves. Indiana Lakes and Streams, Vol 3, No. 1 (1945), pp 1-137.
- Gerking, Shelby D., "Key to the Fishes of Indiana," Inves. Ind. Lakes and Streams, Vol 4 (1955), pp 49-86.
- Hahn, W. L., "The Mammals of Indiana," Dept. Geol. and Nat. Res. 33rd Ann. Rept. (1969), pp 417-654.
- Hay, Oliver Perry, The Amphibians and Reptiles of Indiana, Privately printed (1887), 23 pp.
- Lyon, M. W., Jr., "Franklin's Ground Squirrel and its Distribution in Indiana," Amer. Midl. Natur., Vol 13 (1932), pp 16-21.
- Lyon, Marcus Ward, Jr., "Mammals of Indiana," Amer. Midl. Natur., Vol 17, No. 1 (1936), pp 1-384.

Minton, S. A., "Introduction to the Study of the Reptiles of Indiana," Amer. Midl. Natur., Vol 32, No. 2 (1944), pp 438-477.

Minton, Sherman A., Jr., "Amphibians and Reptiles of Indiana," Indianapolis: Indiana Academy of Sci., Monog. No. 3 (1972).

Mumford, R. E. and R. D. Kirkpatrick, "Distribution of the 13-lined Ground Squirrel in Indiana," Proc. Indiana Acad. Sci., Vol 70 (1961), pp 275-277.

Mumford, Russell E., Distribution of the Mammals of Indiana (Ind. Acad. Sci., 1969), 114 pp.

Peattie, D. C., Flora of the Indiana Dunes (Chicago: Field Mus. Natur. Hist., 1930), 432 pp.

Smith, Philip W. and Sherman A. Minton, Jr., "A Distributional Summary of the Herptofauna of Indiana and Illinois," Amer. Midl. Nat., Vol 58, No. 2 (1957), pp 341-351.

Iowa

Aitkin, Walter W., Some Common Iowa Fishes, Iowa State Coll. Ext. Circ. 224 (1936), 33 pp.

Anderson, R. M., "The Birds of Iowa," Proc. Davenport Acad. Sci., Vol 9 (1907), pp 125-417.

Bailey, B. H., "The Raptorial Birds of Iowa," Bull. Iowa Geol. Survey, Vol 6 (1918), pp 1-238.

Blanchard, F. N., "The Amphibians and Reptiles of Dickinson County, Iowa," Univ. Iowa Stud. Nat. Hist., Vol 10 (1921), pp 19-28.

Bowles, J. B., "Distribution and Biogeography of Mammals of Iowa," Spec. Publs., The Museum, Texas Tech. Univ., Vol 9 (1975), pp 1-184.

Brennan, K. M., The Vertebrate Fauna of Kalsow Prairie, Devel. Ser. Rep. 5 (Iowa City: Iowa State Adv. Board. for Preserves, 1969), 30 pp.

Conard, H. W., "The Vegetation of Iowa," State Univ. Iowa Studies Nat. Hist., Vol 19, No. 4 (1952), pp 1-178.

Guthrie, J. E., "The Snakes of Iowa," Ames: Iowa State College of Agric. and Mech. Arts, Agric. Experiment Station, Bull. No. 239 (1926).

- Harlan, James R. and Everett B. Speaker, Iowa Fishes and Fishing (Des Moines: Iowa State Cons. Comm., 1951), 237 pp. Keys and description of fishes of Iowa with excellent illustrations.
- Hendrickson, George O., "Studies on the Insect Fauna of Iowa Prairies," Iowa St. College Jour. Sci., Vol 4 (1930), pp 49-179.
- Klongan, E. D., H. L. Gladfelter, R. C. Sheets and G. Hlauka, "Current Status of the Woodcock in Iowa," Proc. Iowa Acad. Sci., Vol 82 (1976), pp 191-193.
- Kozicky, E. L., R. J. Jessen, G. O. Hendrickson, and E. B. Speaker. "Estimation of Fall Quail Populations in Iowa," Journal of Wildlife Management, Vol 20, No. 2 (1956), pp 97-104.
- Larsen, J. A. and J. R. Dilworth, "Forests of Southern Iowa," Proc. Iowa Acad. Sci., Vol 46 (1939), pp 141-147.
- Scott, T. G., "Mammals of Iowa," Iowa State Coll. Jour. Sci., Vol 12, No. 1 (1937), pp 43-98.
- Shimek, B., "Land Snails as Indicators of Ecological Conditions," Ecology, Vol 11 (1930), pp 673-686.
- Shimek, B., "The Plant Geography of Iowa," Univ. Iowa Studies Nat. Hist. Vol 18 (1948), pp 1-178.

Kansas

- Beasley, C. W., "Tardigrades From Kansas," Trans. Kans. Acad. Sci., Vol 70 (1967), pp 464-470.
- Black, J. D., "Mammals of Kansas," Kansas State Board Agr., 30th Ann. Rept. (1938), pp 116-217.
- Cockrun, E. Lendell, Mammals of Kansas, Univ. Kansas Publs., Mus. Nat. Hist., Vol 7 (1952), pp 1-303.
- Collins, Joseph T., Amphibians and Reptiles in Kansas (Univ. Kan. Mus. Nat. Hist., 1974).
- Cross, F. B., Handbook of Fishes of Kansas, Univ. Kansas Mus. Nat. Hist., Misc. Publ., No. 45 (1967), pp 1-357.
- Field, William D., A Manual of the Butterflies and Skippers of Kansas . . ., Bulletin of the University of Kansas, Lawrence, Kansas (1938).
- Gaines, Michaels and Robert L. Rose, "Population Dynamics of *Microtus ochrogaster* in Eastern Kansas," Ecology, Vol 51, No. 6 (1976).

- Hall, E. R., Handbook of Mammals of Kansas, Univ. Kansas Mus. Nat. Hist., Misc. Publ., No. 7 (1955).
- Horst, Thomas J., "Population Dynamics of the Burrowing Mayfly *Hexagenia limbata*," Ecology, Vol 57, No. 1 (1976).
- Johnston, R. M., The Breeding Birds of Kansas, Univ. Kansas Publs., Mus. Nat. Hist., Vol 12 (1964), pp 575-655.
- Jones, J. K., Jr., E. D. Fleharty and P. B. Dunnigan, The Distributional Status of Bats in Kansas, Univ. Kansas Mus. Nat. Hist., Misc. Publ. No. 46 (1967), pp 1-33.
- Kuchler, A. W., "A New Vegetation Map of Kansas," Ecology, Vol 55 (1974), pp 586-604.
- Smith, Hobart M., Handbook of Amphibians and Reptiles of Kansas, Univ. Kan. Publ, Misc. Publ., No. 2 (1950), 113 pp.
- Smith, Hobart M., Handbook of Amphibians and Reptiles of Kansas, 2nd ed., Univ. Kansas, Mus. Nat. Hist., Misc. Publ. No. 9 (1956), 356 pp.
- Stephens, H. A., Trees, Shrubs, and Woody Vines in Kansas (Lawrence: Univ. Kan. Press, 1969), 250 pp.

Kentucky

- Bailey, Vernon, "Cave Life in Kentucky: Mainly in the Mammoth Cave Region," Amer. Mid. Nat., Vol 14, No. 5 (1933), pp 385-635.
- Barbour, Roger W., Amphibians and Reptiles of Kentucky (Lexington: Univ. Press of Kentucky, 1971).
- Barbour, Roger W., and Wayne H. Davis, Mammals of Kentucky, Kentucky Nature Studies 5, (The Univ. Kentucky Press, 1974), pp xii + 322 pp.
- Hamilton, W. J., Jr., "Notes on the Mammals of Breathitt County, Kentucky," Jour. Mammal., Vol 11 (1930), pp 306-311.
- Mengel, R. M., The Birds of Kentucky, Ornithol. Monogr. (1965), 581 pp.
- Prins, R., "Comparative Ecology of the Crayfishes *Orgonectes rusticus* and *Cambarus tenebrosius*, in Doe Run, Meade Co., Kentucky," Int. Rev. Gesamten Hydrobid., Vol 53 (1968), pp 667-714.
- Rhoades, R., "The Crayfishes of Kentucky, With Notes on Variation, Distribution and Descriptions of New Species and Subspecies," Amer. Midl. Nat., Vol 32 (1944), pp 111-149.

Welter, W. A. and D. E. Sollberger, "Notes on the Mammals of Rowan and Adjacent Counties in Eastern Kentucky," Jour. Mammal., Vol 20 (1939), pp 77-81.

Wharton, Mary E. and R. W. Barbour, The Wildflowers and Ferns of Kentucky (Lexington: Univ. Kentucky Press, 1971).

Wharton, Mary E. and Roger W. Barbour. Trees and Shrubs of Kentucky (Lexington: Univ. Press of Kentucky, 1973), 582 pp.

Williamson, John, Ferns of Kentucky (Louisville, Ky.: John P. Morton & Co., 1878).

Louisiana

Arthur, S. C., "The Fur Animals of Louisiana," Lousiana Dept. Conserv. Bull., Vol 18 (1931), pp 1-444.

Brown, Clair A., Louisiana Trees and Shrubs, Louisiana For. Comm. Bull. No. 1, Baton Rouge (1965), 262 pp.

Brown, Clair A., Wildflowers of Louisiana and Adjoining States (Baton Rouge: Louisiana State Univ. Press, 1972), 247 pp.

Cagle, F. R., "A Louisiana Terrapin Population, (Malaclemys)," Copera (1952), pp 74-76.

Cagle, F. R. and A. H. Chaney, "Turtle Populations in Lousiana," Amer. Midl. Natur., Vol 43 (1950), pp 383-388.

Dorman, Caroline, Wildflowers of Louisiana (New York: Doubleday, Donan, & Co., 1934).

Dundee, Harold A. and Douglas A. Rossman, Amphibians and Reptiles of Louisiana. (In preparation.)

Ellis, L. L., "The Aquatic Hemiptera of Southeastern Louisiana (Exclusive of the Corixidae)," Amer. Midl. Nat., Vol 48 (1952), pp 302-329.

Keiser, Edmund D., Jr., and Larry David Wilson, Checklist and Key to the Herpetofauna of Louisiana, Lafayette: Lafayette Nat. Hist. Mus., Tech. Bull. No. 1 (1969).

Lowery, G. H., Jr., The Mammals of Louisiana and its Adjacent Waters (Baton Rouge: Louisiana State Univ. Press, 1974), 565 pp.

Maine

- Davis, R. B., "Spruce-Fir Forests of the Coast of Maine," Ecol. Monogr., Vol 36 (1966), 79-44.
- Everhart, W. Harry, Fishes of Maine (Ma. Dept. Inland Fish and Game, 1950), 53 pp.
- Manville, R.H. ., "Notes on the Mammals of Mount Desert Island, Maine," Jour. Mammal., Vol 23 (1942), pp 391-398.
- Morse, Douglas H., "Variables Affecting the Density and Territory Size of Breeding Spruce Woods Warblers," Ecology, Vol 57, No 2 (1976).
- Norton, A. H., "Mammals of Portland, Maine, and Vicinity," Proc. Portland Soc. Nat. Hist., Vol 4 (1930), pp 1-151.
- Ogden, Edith Bolan, The Ferns of Maine, Reprinted from the Maine Bulletin, 51, No. 3 (October 1948), at the University Press, Orono, Maine.
- Spight, Tom M., "Sizes of Populations of a Marine Snail," Ecology, Vol 55, No. 4 (1974).

Maryland

- Elser, Harold J., The Common Fishes of Maryland; How to Tell Them Apart, Md. Bd. Nat. Res. Dept. Res. and Ed. Publ. No. 88 (1950), 45 pp.
- Gardner, M. C., A List of Maryland Mammals, "Pt. I, Marsupials and Insectivores," Pt. II, "Bats," Proc. Biol. Soc. Wash., Vol 63 (1950), pp. 65-68; 111-114.
- Goldman, E. A. and H. H. T. Jackson, Natural History of Plummers Island, Maryland, "IX, Mammals," Proc. Biol. Soc. Wash., Vol 52 (1939), pp 131-134.
- Harris, Herbert S., Jr., "Distributional Survey: Maryland and the District of Columbia," Bull. of the Maryland Herpetological Soc., Vol 5 (1969), pp 97-161, Baltimore.
- Hildebrand, S. F. and W. C. Schroeder, "Fishes of Chesapeake Bay," U. S. Bur. Fish. Bull., Vol 43 (1928), pp. 1-388.
- Mansueti, Romeo, A Descriptive Catalogue of the Amphibians and Reptiles Found in and around Baltimore City, Maryland, Baltimore: Nat. Hist. Soc. of Maryland, Proc. No. 7 (1941).

- McCauley, R. W., Jr., The Reptiles of Maryland and the District of Columbia (Hagerstown, Md.: published by the author, 1945), 194 pp.
- Reed, Clyde F., The Ferns and Fern-Allies of Maryland and Delaware, Including District of Columbia (Baltimore, Md.: Reed Herbarium, 1953).
- Stewart, R. E. and C. S. Robbins, "Birds of Maryland and the District of Columbia," North Amer. Fauna, Vol 62 (1958).
- Truitt, R. V., B. A. Bean and H. W. Fowler, The Fishes of Maryland, Md. Cons. Dept., Cons. Bull. No. 3 (1929), 120 pp.

Massachusetts

- Dame, L. L. and F. S. Collins, Flora of Middlesex County, Massachusetts (Malden, Mass.: Middlesex Institute, 1888).
- Forbush, E. H., Birds of Massachusetts and Other New England States. Part I, Water Birds, Marsh Birds, and Shore Birds (Boston, Mass.: Berwick and Smith Company, 1925).
- Forbush, E. H., Birds of Massachusetts and Other New England States. Part II, Land Birds From Bobwhites to Grackles (Boston, Mass.: Berwick and Smith Company, 1927).
- Forbush, E. H., Birds of Massachusetts and Other New England States, Vol. 3 (Massachusetts Dept. of Agr., 1929).
- Hoffmann, Ralph, "The Flora of Berkshire County, Massachusetts," Proceedings of The Boston Society of Natural History, Vol 36, No. 5 (1922), pp 171-382.
- Parker, H. C., "A Preliminary List of the Mammals of Worcester County, Massachusetts," Proc. Boston Soc. Nat. Hist., Vol 41 (1939), pp 403-415.
- Robinson, John, The Flora of Essex County, Massachusetts (Salem, Mass.: Essex Institute, 1880).
- Storer, D. Humphreys, Reptiles of Massachusetts in Reports on the Fishes, Reptiles, and Birds of Massachusetts (Boston: Commissioners Zoological and Botanical Survey of Massachusetts) 426 pp.
- Warfel, H. E., "Notes on Some Mammals of Western Massachusetts," Jour. Mammal, Vol 18 (1937), pp 82-85.

Michigan

- Allen, D. L., Michigan Fox Squirrel Management, Game Div. Publ. 100, Mich. Dept. Conservation (1943), 404 pp.
- Ammann, G. A., The Prairie Grouse of Michigan (Lansing: Mich. Dept. Conserv., 1957).
- Billington, Cecil, Ferns of Michigan, Cranbrook Institute of Science, Bulletin No. 32, Bloomfield Hills, Mich., 1952.
- Bradt, Glenn W., "A Study of Beaver Colonies in Michigan," Jour. Mammal., Vol 19 (1938), pp 139-162.
- Burrows, W. D., Michigan Bird Life, Bull. Dept. Zool. and Physiol. Mich. Agric. Coll. (1912).
- Burt, William H., The Mammals of Michigan (Ann Arbor: Univ. Mich. Press, 1946), 288 pp.
- Burt, William H., Mammals of the Great Lakes Region (Ann Arbor: Univ. Mich. Press, 1957).
- Crawford, R. D., "High Population Density of *Microtus ochrogaster*," J. of Mammalogy, Vol 52, No. 2 (1971).
- Downs, W., Fish of Lake Michigan, Univ. Wisconsin Sea Grant College Program, Wis-SG-74-121 (1975), 32 pp.
- Hiltunen, J. K., A Laboratory Guide: Keys to the Tubificid and Vaidid Oligochacta of the Great Lakes Regions (Ann Arbor: Great Lakes Fish. Res. Lab., 1973).
- Hubbs, C. L., A Check-List of the Fishes of the Great Lakes and Tributary Waters, With Nomenclatorial Notes and Analytical Keys, Univ. Mich. Mus. Zool. Misc. Publ. No. 15 (1926), 77 pp.
- Hubbs, Carl L. and Gerald P. "Cooper, Minnows of Michigan," Bull. Cranbrook Instit. Sci., No. 8 (1936), 95 pp.
- Hubbs, C. L. and K. F. Lagler, "Fishes of the Great Lakes Regions," Cranbrook Inst. Sci. Bull., Vol 26 (1947), pp 1-186.

Hubbs, Carl L. and Karl F. Lagler, Fishes of the Great Lakes Region (Ann Arbor: Univ. of Mich. Press, 1964), 213 pp. Keys and ranges of the fishes of the Great Lakes drainage with illustrations.

Hubbs, C. L. and K. F. Lagler, Keys for the Identification of the Fishes of the Great Lakes and Tributary Waters (Ann Arbor: Privately published, 1939), 37 pp.

Koelz, Walter, "Coregonid Fishes of the Great Lakes," Bull. U. S. Bur. Fish., Vol 43 (1927), Pt. 2: pp. 297-643. Detailed descriptions of all coregonid fishes inhabiting the Great Lakes, with illustrations.

Kormondy, E. J., Catalogue of the Odonata of Michigan, Misc. Publ. Mus. Zool., Univ. Mich., No. 104 (1958).

Leonard, J. W. and F. A. Leonard, An Annotated List of Michigan Trichoptera, Occas. Papers Mus. Zool., Univ. Mich., Vol 522 (1949), pp 1-35.

Leonard, J. W. and F. A. Leonard, Mayflies of Michigan Trout Streams (Bloomfield Hills, Mich.: Cranbrook Inst. Sci., 1962), 139 pp.

Mech, L. D., The Wolves of Isle Royale, U. S. Natl. Park Serv., Fauna Natl. Parks U. S. Fauna Ser., 7 (1966), 210 pp.

Pearse, A. S., "A Preliminary List of Crustacea of Michigan," Michigan Acad. Sci., Arts, Lett. Vol 12 (1910), pp 68-76.

Rappole, J. H., D. W. Warner, M. O. Ramos, "Territoriality and Population Structure in a Small Passerine Community," The Amer. Midland Naturalist, Vol 97, No. 1 (1977).

Ruthven, Alexander G., Crystal Thompson and Helen T. Gaige, The Herpetology of Michigan, Ann Arbor: University Museums, U. of Michigan, Handbook Ser., No. 3 (1928).

Smith, A. H., Puffballs and Their Allies in Michigan, (Ann Arbor: University of Michigan Press, 1951).

Minnesota

Bray, J. R., D. B. Lawrence and L. C. Pearson, "Primary Production in Some Minnesota Terrestrial Communities for 1957," Oikos, Vol 10 (1959), pp 38-49.

Breckenridge, Walter J., Reptiles and Amphibians of Minnesota (Univ. Minn. Press, 1944), 202 pp.

Daubenmire, R. F., "The 'Big Woods' of Minnesota," Ecol. Monogr., Vol 6 (1936), pp 233-268.

Eddy, Samuel and T. Surber, Northern Fishes with Special Reference to the Upper Mississippi Valley (Minneapolis: Univ. of Minn. Press, rev. ed., 1947), 276 pp. Keys and descriptions of the fishes of Minnesota with illustrations.

Erickson, A. F., V. E. Gunvalson, M. H. Stenlund, D. W. Burcalow and L. H. Blankenship, "The White Tailed Deer of Minnesota," Minn. Div. Game and Fish Tech. Bull., Vol 5 (1961), 64 pp.

Gunderson, H. L. and J. R. Beer, The Mammals of Minnesota, Minn. Mus. Nat. Hist., Occ. Paper No. 6 (1953).

Gunderson, Harvey L. and James R. Beer, The Mammals of Minnesota (Minneapolis: Univ. Minn. Press, 1953), 190 pp.

Mech, L. David, "Productivity, Mortality and Population Trend of Wolves in Northeastern Minnesota," J. of Mammology, Vol 58, No. 4 (1977).

Moyle, John and Neil Hotchkiss, The Aquatic and Marsh Vegetation of Minnesota and its Value to Waterfowl, Minn. Dept. Conserv., Tech. Bull. No. 3 (1969).

Peek, J. M., R. E. LeResche, D. Stevens, "Dynamics of Moose Aggregations in Alaska, Minnesota and Montana," J. of Mammology, Vol 55, No. 1 (1974).

Roberts, T. S., The Birds of Minnesota (Minneapolis: Univ. Minn. Press, 1936), 850 pp.

Roberts, Thomas S., Manual for the Identification of the Birds of Minnesota and Neighboring States (Univ. Minn. Press, 1955).

Surber, Thaddeus, The Mammals of Minnesota (St. Paul, 1932).

Swanson, Gustav, Thaddeus Surber and Thomas S. Roberts, The Mammals of Minnesota, Minn. Dept. Cons. Tech. Bull. 2 (1945), 108 pp.

Tryon, Rolla M., Jr., The Ferns and Fern Allies of Minnesota (Minneapolis: University of Minnesota Press, 1954).

Mississippi

Caplenor, Donald, "Forest Composition on Loessal and Non-Loessal Soils in West Central Mississippi," Ecology, Vol 49, No. 2 (1968).

Cook, F. A., Game Animals of Mississippi, Surv. Bull. Miss. Stat. Game and Fish Comm. (1943, Mimeo).

Cook, Fannye A., Fur Resources of Mississippi, Survey Bull., Mississippi State Game and Fish Comm. (1945), 100 pp.

Cook, Fannye A., Snakes of Mississippi (1954); Alligator and Lizards of Mississippi (1957); and Salamanders of Mississippi (1957), Jackson: Mississippi Game and Fish Commission.

Kennedy, M. L., K. N. Randolph and T. L. Best, "A Review of Mississippi Mammals," Nat. Sci. Res. Inst., Eastern N. Mex. Univ., Studies in Nat. Sci., Vol 2 (1974), pp 1-36.

Peggingill, O. S., Jr., A Guide to Bird Finding East of the Mississippi (New York: Oxford Univ. Press, 1978).

Stockard, C. R., "Nesting Habits of Birds of Mississippi," Auk, Vol 22, (1905), pp 146-158.

Wilson, C. A., "Aquatic and Semiaquatic Hemispheres of Mississippi," Tulane Stud. Zool., Vol 6 (1958), pp 115-170.

Missouri

Anderson, Paul, The Reptiles of Missouri (Columbia: University of Missouri Press, 1965).

Bennitt, R., Some Aspects of Missouri Quail and Quail Hunting, 1939-1948, Missouri Conservation Commission, Technical Bulletin 2 (1951).

Bennitt, Rudolf and Werner O. Nagel, "A Survey of the Resident Game and Fur Bearers of Missouri," Univ. Missouri Stud., Vol 12, No. 2 (1937), pp 1-215.

Hurter, Julius, Sr., "Herpetology of Missouri," Transactions of the Academy of Sci. of St. Louis, Vol 20 (1911), pp 59-274.

Pflieger, W. L., "A Distributional Study of Missouri Fishes," Univ. Kansas Publ. Mus. Nat. Hist., Vol 20 (1971), pp 225-570.

Pflieger, W. L., The Fishes of Missouri (Missouri: Department of Conservation, 1975), 343 pp.

Schwartz, C. W., The Prairie Chicken in Missouri (Jefferson City: Conserv. Comm., 1944).

Schwartz, C. W. and E. R. Schwartz, The Wild Mammals of Missouri (Univ. Missouri Press and Missouri Conser. Comm. 1959), 341 pp.

Montana

- Elrod, Morton John, The Butterflies of Montana (U. of Montana, 1906).
- Hoffman, R. S., P. L. Wright and F. E. Newby, "The Distribution of Some Mammals in Montana: I. Mammals Other Than Bats," J. Mammal., Vol 50, No. 3, pp 579-604.
- Hodgson, J. R., "Local Distribution of *Microtus montanus* and *M. pennsylvanicus* in Southeastern Montana," J. of Mammology, Vol 53, No. 3 (1972).
- Lampe, R. P., J. K. Jones, Jr., R. S. Hoffmann and E. C. Birney, The Mammals of Carter County, Southeastern Montana, Occas. Papers Mus. Nat. Hist., Univ. Kansas, Vol 25 (1974), pp 1-39.
- Lechleitner, R. R., Mammals of Glacier National Park, Glacier Nat. Hist. Assoc. Bull. No. 6 (1955).
- Manville, R. H., "The Columbian Ground Squirrel in Northwestern Montana," J. Mammal., Vol 40 (1959), pp 26-45.

Nebraska

- Hudson, George E., The Amphibians and Reptiles of Nebraska, Lincoln: U. of Nebraska, Nebraska Conservation Bull. No. 24 (1942).
- Jones, J. K., "Checklist of Mammals of Nebraska," Trans. Kans. Acad. Sci., Vol 60 (1957), pp 273-282.
- Jones, J. K. Jr., Distribution and Taxonomy of Mammals of Nebraska, Univ. Kansas Publs., Mus. Nat. Hist., Vol 16 (1964), pp 1-356.

Nevada

- Beatley, J. C., "Biomass of Desert Winter Annual Plant Populations in Southern Nevada," Oikos, Vol 20 (1969), pp 261-273.
- Beatley, J. C., Vascular Plants of the Nevada Test Site, Nellis Air Force Range, and Ash Meadows (Northern Mojave and Southern Great Basin Deserts South-Central Nevada), UCLA 12-705, Univ. Calif. Los Angeles (1969), 122 pp.
- Beatley, Janice C., "Environments of Kangaroo Rats and Effects of Environmental Change in Populations in Southern Nevada," J. of Mammology, Vol 57, No. 1 (1976).
- Beatley, Janice C., Vascular Plants of the Nevada Test Site and Central-Southern Nevada: Ecologic and Geographic Distributions, Tech. Inf. Center ERDA, Oak Ridge, Tenn. (1976), 308 pp.

Hall, E. Raymond, Mammals of Nevada (Berkeley: Univ. Calif. Press, 1946), pp i-xi, 1-710.

La Rivers, I., Fishes and Fisheries of Nevada (Carson City: State Printing Office, 1962), 781 pp.

Tanner, W. W. and C. D. Jorgenson, Reptiles of the Nevada Test Site, Brigham Young Univ. Sci. Bull. Biol. Ser. 3 (1963), 31 pp.

Thomas, J. H. and D. R. Parnell, Native Shrubs of the Sierra Nevada, Calif. Nat. Hist. Guide 34, Univ. Calif. Press, Berkeley (1974), 127 pp.

New Hampshire

Aiken, D. E., "Distribution and Ecology of Three Species of Crayfish From New Hampshire," Amer. Midl. Natl., Vol 73 (1965), pp 240-244.

Behney, W. H., "Food Organisms of Some New Hampshire Trout Streams," New Hampshire Fish and Game Dept., Surv. Rept., Vol 2 (1937), pp 77-80.

Chittenden, A. K., Forest Conditions of Northern New Hampshire, U. S. Dept. Agr. Bur. For. Bull., Vol 55 (1905), 100 pp.

Jackson, C. F., "Notes on New Hampshire Mammals," Jour. Mammal., Vol 3 (1922), pp 313-315.

Oliver, James A. and Joseph R. Bailey, "Amphibians and Reptiles of New Hampshire," Biological Survey of the Connecticut Watershed, pp 195-217 (1939), Concord.

Scamman, Edith, Ferns and Fern Allies of New Hampshire, Bulletin No. 2, New Hampshire Academy of Science, Durham, N.H., 1947. Printed by Smith & Town, Berlin, N.H.

Shive, Donald J., "Ecological Relationships of Small Mammals in a New Jersey Barries Beach Habitat," J. of Mammalogy, Vol 51, No. 2 (1970).

Stott, R. S. and D. P. Olson., "An Evaluation of Waterfowl Surveys on the New Hampshire Coastline," Journal of Wildlife Management, Vol 36, No. 2 (1972), pp 468-471.

New Jersey

Chrysler, M. A. and J. L. Edwards, The Ferns of New Jersey, Including the Fern Allies (New Brunswick, N.J.: Rutgers University Press, 1947).

Comstock, William P., "Butterflies of New Jersey," Journal of the New York Entomological Society, Vol 48 (1940), pp 47-84.

Conant, Roger. Amphibians and Reptiles of New Jersey and the Delmarva Peninsula. (In preparation.)

Connor, P. F., "Notes on the Proposals of a New Jersey Pine Barrow Area," Jour. Mammal., Vol 34 (1953), pp 227-235.

Fowler, Henry A., The Fishes of New Jersey, Ann. Rept. N. J. State Mus., 1905, Pt 2 (1906), pp 35-477.

Leck, Charles, Birds of New Jersey: Their Habits and Habitats (New Brunswick, N.J.: Rutgers Univ. Press, 1975), 190 pp.

Ohmann, L. F. and M. F. Buell, "Forest Vegetation of the New Jersey Highland," Bull. Torrey Bot. Club, Vol 95 (1968), 287-298.

Robichaud, B. and M. F. Buell, Vegetation of New Jersey: A Study of Landscape Diversity (New Brunswick, N.J.: Rutgers Univ. Press, 1973).

New Mexico

Bailey, F. M., Birds of New Mexico (Santa Fe: New Mexico Dept. Game and Fish, 1928).

Bailey, V., Mammals of New Mexico, N. Amer. Fauna, Vol 53 (1931), 412 pp.

Choate, G. A., New Mexico's Forest Resource, U. S. For. Serv. Resour. Bull. Int., Vol 5 (1966), iii + 58 pp. Map.

Dice, Lee R., "Ecological Distribution of Peromyscus and Neotoma in Parts of Southern New Mexico," Ecology, Vol 23 (1942), pp 199-208.

Dye, A. J. and W.H. Moir, "Spruce-Fir Forest at its Southern Distribution in the Rocky Mountains, New Mexico," Amer. Midl. Natur., Vol 97, No. 1, pp 133-146.

Findley, J. S., A.H. Harris, D. E. Wilson, and C. Jones, Mammals of New Mexico (Univ. New Mexico Press, 1975), 360 pp.

Hubbard, J. P., Check-List of the Birds of New Mexico, New Mexico Ornithol. Soc. Publ. No. 3 (1970).

Koster, Wm. J., Guide to the Fishes of New Mexico, Univ. of New Mexico Press and the Dept. of Game and Fish (1957), 116 pp.

Ligon, J. S., New Mexico Birds and Where to Find Them (Albuquerque: Univ. New Mexico Press, 1961).

Vegetative Type Map of New Mexico, New Mexico Ag. Exp. Stn., Las Cruces: New Mexico College of Agriculture and Mechanical Arts, 1957.

New York

Bean, Tarleton H., Catalogue of the Fishes of New York, N.Y.S. Mus. Bull., Vol 60 (1903), 784 pp.

Betten, C. B., The Caddis Flies or Trichoptera of New York State, Bull. N.Y. State Mus., No. 292 (1934), pp 1-576.

Bishop, S. C., The Salamander of New York, N.Y. State Mus. Bull., No. 324 (1941), pp 1-365.

Brooks, Maurice, "The Breeding Warblers of the Central Allegheny Mountain Region," Wilson Bull., 52 (1940), pp 249-266.

Bull, John, Birds of New York State. (Garden City, N.Y.: Doubleday, 1974).

Connor, R. F., The Animals of Long Island, New York, N.Y.S. Mus. and Sci. Serv., Bull., No. 416 (1971).

Crocker, D. W., The Crayfishes of New York State (Decapods, Astacidae), N. Y. State Mus. Sci. Serv. Bull., No. 355 (1937), pp 1-97.

Eaton, E. H., Birds of New York, Part 2, Albany: N. Y. State Mus., Memoir 12 (1914).

Eaton, Theodore H., Jr. and Robert F. Chandler, Jr., The Fauna of the Forest Humus Layers in New York, Cornell Univ. Agr. Exp. Sta. Mem. 247 (1942), pp 1-26.

Forbes, W. T. M., Lepidoptera of New York and Neighboring States, Part II, Cornell Univ. Agric. Exp. Stn. Mem. 274 (1948).

Kirkland, G. L. and R. J. Griffin, "Microdistribution of Small Mammals of the Coniferous Deciduous Forest Ecotone in Northern New York," J. of Mammology, Vol 55, No. 2 (1974).

Komarck, E. V. and Roy Komarck, "Mammals of the Great Smoky Mountains" Bull. Chic. Acad. Sci., Vol 5 (1938), pp 137-162.

Maynard, Elliott A., A Monograph of the Collembola or Springtail Insects of New York State (Ithaca, N. Y.: Comstock, 1951).

McIntosh, Robert P., The Forest of the Catskill Mountains, New York (Cornwallville, New York: Hope Farm Press, 1977), 27 pp.

Parkhurst, Howard Elmore, Songbirds and Waterfowl of New York (New York: Charles Scribner's Sons, 1927).

Sheldon, Andrew, "Species Diversity and Longitudinal Succession in Stream Fishes," Ecology, Vol 49, No. 2 (1968).

Small, John Kunkel, Ferns of the Vicinity of New York (Lancaster, Pa.: Science Press Printing Co., 1935).

North Carolina

Brimley, C. S., The Amphibians and Reptiles of North Carolina, Raleigh: Carolina Tips (Printed by author in 32 installments, 1939 to 1943, inclusive).

Conaway, C. H. and J. C. Howell, "Observations on the Mammals of Johnson and Carter Counties, Tennessee, and Avery County, North Carolina," Jour. Tenn. Acad. Sci., Vol 28 (1953), pp 53-61.

Cooper, J. E., S. S. Robinson, and J.B. Funderberg, Endangered and Threatened Plants and Animals of North Carolina (Raleigh: North Carolina State Mus. of Nat. Hist., 1977), 444 pp.

Engels, W. L., "Vertebrate Fauna of North Carolina Coastal Islands," Amer. Midl. Natur., Vol 28 (1942), pp 273-304.

Huheey, James E. and Arthur Stupka, Amphibians and Reptiles of Great Smoky Mountains National Park (Knoxville: U. of Tennessee Press, 1967).

Justice, W. S. and C. R. Bell, Wild Flowers of North Carolina (Chapel Hill: Univ. North Carolina Press, 1968).

Komarek, E. V. and Roy Komarek, "Mammals of the Great Smokey Mountains," Bull. Chicago Acad. Sci., Vol 5 (1938), pp 137-162.

Odum, E. P., "Small Mammals of the Highland (North Carolina) Plateau," Jour. Mammal., Vol 30 (1949), pp 179-192.

Odum, E. P., "Small Mammals of the Highlands (North Carolina) Plateau," Jour. Mammal., Vol 30 (1949), pp 179-192.

Oosting, H. J., "An Ecological Analysis of the Plant Communities of Piedmont North Carolina," Am. Midl. Nat., Vol 28 (1942), pp 1-126.

Palmer, William M., et al., Amphibians and Reptiles of North Carolina (In preparation).

Palmer, William M., Poisonous Snakes of North Carolina (Raleigh: State Mus. of Nat. Hist., 1974).

Pearson, T. G., Birds of North Carolina (Raleigh: Bynum Print. Co., 1942).

Smith, Hugh M., The Fishes of North Carolina, North Carolina Geol. and Econ. Surv., Vol 2 (1907), pp. xi-453. Although out of date, still the most authoritative account of the fishes of this region.

Wells, B. W. and I. U. Shunk, "The Vegetation and Habitat Factors of the Coarser Sands of the North Carolina Coastal Plain," Ecol. Monogr., Vol 1 (1931), pp 465-520.

Williams, Samuel Howard, The Mammals of Pennsylvania (Published by the author, 1928).

North Dakota

Bailey, V., "A Biological Survey of North Dakota. I. Physiography and Life Zones; II. The Mammals," N. Amer. Fauna, Vol 49 (1926), pp 1-226.

Dix, R. L. and F. E. Smeins, "The Prairie, Meadow, and Marsh Vegetation of Nelson County, North Dakota," Can. Jour. Bot., Vol 45 (1967), pp 21-58.

Hadley, E. B. and R. P. Buccos, "Plant Community Composition and Net Primary Production Within a Native Eastern North Dakota Prairie," Amer. Midl. Natur., Vol 77 (1967), pp 116-127.

Puckering, D. L. and R. L. Post, Butterflies of North Dakota, Dept. Agric. Entomol., N. D. Agric. Coll. Publ. No. 1 (1960), 32 pp.

Saugstad, S., "Aerial Census of Big Game in North Dakota," Transactions, North American Wildlife Conference, Vol 7 (1942), pp 343-356.

Stewart, R. E., Breeding Birds of North Dakota, Tri-College Center for Environmental Studies, North Dakota State Univ., Fargo (1975), 295 pp.

Wheeler, George C. and Jeanette Wheeler, The Amphibians and Reptiles of North Dakota (Grand Forks: U. of North Dakota Press, 1966).

Ohio

- Beatley, Janice C., "The Winter-Green Herbaceous Flowering Plants of Ohio," Ohio Jour. Sci., Vol 56 (1956), pp 349-377.
- Bole, B. P., Jr. and P. N. Moulthrop, "The Ohio Recent Mammal Collection in the Cleveland Museum of Natural History," Cleveland Mus. Nat. Hist. Sci. Publ., Vol 5, No. 6, pp 83-181.
- Braun, E. L., The Monocotyledoneae Vascular Flora of Ohio, Volume 1 (Columbus: Ohio State University Press, 1967).
- Braun, E. Lucy, The Woody Plants of Ohio (Columbus: Ohio State University Press, 1961).
- Conant, Roger, The Reptiles of Ohio, 2nd ed. (Notre Dame, Ind.: The American Midland Naturalist, 1951), pp 1-284.
- DeCoursey, G. E., Jr., Identification, Ecology, and Reproduction of Microtus in Ohio, J. Mammal., Vol 38, No. 1, pp 44-52.
- Hopkins, L. S., "The Fern Flora of Ohio," Fern Bulletin, Vol 15 (1907), pp 1-13.
- Johnson, D. M., "Leafhoppers of Ohio, Subfamily Typhlocybinae (Homoptera; Cicadellidae)," Ohio Biol. Surv. Bull., Vol 31 (1935), pp 34-122.
- Mills, R. S., G. W. Barrett, M. P. Farrell, "Population Dynamics of the Big Brown Bat in Southwestern Ohio," J. of Mammology, Vol 56, No. 3 (1975).
- Olson, H. W., "The Earthworms of Ohio," Ohio Biol. Survey, Vol 4 (1928), pp 45-90.
- Schaffner, John H., Revised Catalog of Ohio Vascular Plants, (Columbus, O.: Ohio State University, 1932).
- Sears, P. B., "The Natural Vegetation of Ohio," Ohio Jour. Sci., Vol 25 (1925), pp 139-146; 26: 128-146; 139-231.
- Smith, Graham, "Population Characteristics of the Porcupine in Northeastern Ohio," J. of Mammology, Vol 58, No. 4 (1977).
- Trautman, M. B., The Fishes of Ohio (Columbus: Ohio State Univ. Press, 1957), 683 pp.
- Vannorsdall, Harry H., Ferns of Ohio (Wilmington, O.: Published by the author, 1956).
- Walker, Charles F., The Amphibians of Ohio: Part I, The Frogs and Toads, Columbus: Ohio State Mus. Sci. Bull., Vol 1, No. 3 (1946), pp 1-109.

Oklahoma

- Beasley, Clark W., "The Tardigrades of Oklahoma," Amer. Midl. Nat., Vol. 99, No. 1, pp 128-141.
- Blair, W. F., "Faunal Relationships and Geographic Distribution of Mammals in Oklahoma," Amer. Mid. Nat., Vol 22 (1939), pp 85-133.
- Bragg, Arthur N., et al., Researches on the Amphibians of Oklahoma (Norman: Univ. Okla Press, 1950), pp 1-154.
- Bruner, W. E., "The Vegetation of Oklahoma," Ecol. Monogr., Vol 1 (1931), pp 99-188.
- May, E. B. and G. R. Gasaway, "A Preliminary Key to the Identification of Larval Fishes of Oklahoma, with Particular Reference to Canton Reservoir, Including a Selected Bibliography," Okla. Dept. Conserv. Bull., No. 5 (1967), 41 pp.
- Miller, R. J. and H. W. Robison, The Fishes of Oklahoma (Stillwater: Okla. State Univ. Press, 1973).
- Moore, G. A., Oklahoma Fishes With Distributional Notes and Keys, Mimeograph, Oklahoma State Univ., Stillwater (1954).
- Phillips, G., F. Gibbs, and W. Mattoon, Forest Trees of Oklahoma, 9th ed. (Oklahoma City, Oklahoma: For. Div. State Board of Agric., 1959).
- Rice, E. L., "Bottomland Forests of North Central Oklahoma," Ecology, Vol 46 (1965), pp 708-714.
- Rice, E. L. and W. T. Penfound, "The Upland Forest of Oklahoma," Ecology, Vol 40 (1959), pp 593-608.
- Stevenson, Michael M., G. P. Schnell and R. Black. "Factor Analysis of Fish Distribution Patterns in Western and Central Oklahoma," Systematic Zoology, Vol 23, No. 2 (1974).
- Sutton, G. M., Oklahoma Birds: Their Ecology and Distribution With Comments on the Avifauna of the Southern Great Plains (Norman: Univ. Okla Press, 1967), 674 pp.
- Webb, Robert G., Reptiles of Oklahoma (Norman: U. of Oklahoma Press, 1970).

Oregon

- Bailey, A. W. and C. E. Poulton, "Plant Communities and Environmental Interrelationships in a Portion of the Till Amook Burn, Northwestern Oregon," Ecology, Vol 49, No. 1 (1968).

Bailey, V., The Mammals and Life Zones of Oregon, N. Amer. Fauna, No. 55 (1936), 46 pp., USDA Bur. Biol. Surv., Wash., D.C.

Bond, Carl E., Keys to Oregon Freshwater Fishes, Agric. Exp. Sta., Oregon State Univ., Technical Bull. 38 (1961), 42 pp.

Gabrielson, I. N. and S. G. Jewett, Birds of Oregon (Corvallis: Oreg. State College, 1940), 650 pp.

Miller, Frank L., "Distribution Patterns of Black Tailed Deer (*Odocoileus Hemionus Columbianus*) in Relation to Environment," J. of Mammology, Vol 51, No. 2 (1970).

Pennsylvania

Beatty, A. F., G. H. Beatty and H. B. White III, "Seasonal Distribution of Pennsylvania Odonota," Penn. Acad. Sci., Vol 43 (1969), pp 119-126.

Canan, Elsie Deane, A Key to the Ferns of Pennsylvania (Lancaster, Pa.: Science Press Printing Co., 1946).

Clute, Willard N., The Ferns and Fern Allies of the Upper Susquehanna Valley (Binghamton, N.Y.: W. N. Clute & Co., 1898).

Fowler, Henry A., "A List of the Fishes of Pennsylvania," Proc. Biol. Soc. Wash., Vol 32 (1919), pp 49-73.

Gifford, C. L. and Ralph Whitebread, Mammal Survey of South Central Pennsylvania (Penna. Game Comm., 1951).

Grimm, W. C. and H. A. Roberts, Mammal Survey of Southwestern Pennsylvania (Penna. Game Comm., 1950).

Grimm, W. C. and Ralph Whitebread, Mammals Survey of Northeastern Pennsylvania (Penna. Game Comm., 1952).

Harrison, Hal H., Pennsylvania Reptiles & Amphibians (Harrisburg: Reprinted from the Pennsylvania Angler, Pennsylvania Fish Commission, 1949-50).

Keever, C., "Distribution of Major Forest Species in Southeastern Pennsylvania," Ecol. Monogr., Vol 43 (1973), pp 303-327.

Ortmann, A. E., "The Crawfishes of the State of Pennsylvania," Mem. Carnegie Mus., 2 (1906), pp 343-524.

Poole, Earl L., Pennsylvania Birds: An Annotated List (Livingston, 1963).

Richmond, N. D. and H. R. Roslund, Mammal Survey of Northwestern Pennsylvania (Penna. Game Comm. and U. S. Fish and Wildl. Serv., 1949).

Roback, S. S., The Immature Tendipedids of the Philadelphia Area, Acad. Nat. Sci. Monogr., No. 9 (1957).

Roberts, H. A. and R. C. Early, Mammal Survey of Southeastern Pennsylvania, Final Report, Pittman-Robertson Proj. 43-R (Harrisburg: Penn. Game Comm., 1952), 70 pp.

Surface, H. A., "The Lizards of Pennsylvania," Pa. Dept. Ag. Div. Zool. Bull., Vol 5, No. 8, pp 233-258.

Surface, H. A., "The Serpents of Pennsylvania," Pa. Dept. Ag. Div. Zool. Bull., Vol 4, Nos 4-5, pp 113-202.

Walker, P. C. and R. T. Hartman, "The Forest Sequence of the Hartstown Bog Area in Western Pennsylvania," Ecology, Vol 41 (1960), pp 461-474.

Rhode Island

Wright, Kenneth E. and Dorothy L. Crandall, "Rhode Island Ferns," Torrey, Vol 41 (1941), pp 73-75.

South Carolina

Benke, A. C. and S. S. Benke, "Comparative Dynamics and Life Histories of Coexisting Dragonfly Populations," Ecology, Vol 56, No. 2 (1975).

Penney, J. T., "Distribution and Bibliography of the Mammals of South Carolina," Jour. Mammal., Vol 31 (1950), pp 81-89.

Sprunt, Alexander, Jr. and E. Burnham Chamberlain, South Carolina Bird Life (Univ. S. C. Press, 1970).

South Dakota

Applegate, R. L., "Corinidae (Water Bootman) of the South Dakota Glacial Lake District," Entomol. News, Vol 84 (1973), pp 163-170.

Bailey, R. M. and M. O. Allum, Fishes of South Dakota, Misc. Publ. Mus. Zool. Univ. Mich. No. 119 (1962) 131 pp.

Churchill, Edward P., and William H. Over, Fishes of South Dakota (Pierre: S. D. Dept. Game and Fish, 1933), 83 pp.

Findley, J. S., "Mammals of Clay County, South Dakota," Univ. South Dakota Publ. in Biol., Vol 1 (1956), pp 1-45.

Fishbeck, Dale W. and James C. Underhill, "A Check List of the Amphibians and Reptiles of South Dakota," Proceedings of the South Dakota Academy of Sci., 38 (1959), pp 107-113. Vermillion.

Over, William H., Amphibians and Reptiles of South Dakota, Vermillion: South Dakota Geol. and Nat. Hist. Survey, Bull. No. 12 (1923).

Over, William H. and Edward P. Churchill, Mammals of South Dakota, Univ. South Dakota Mus and Dept. Zool., Mimeograph.

Turner, R. W., Mammals of the Black Hills of South Dakota and Wyoming, Univ. Kansas, Misc. Publ., No. 60 (1974).

Tennessee

Beasley, L. E. and W. D. Severinghaus, "A Survey of the Secretive Rodents of West Tennessee," J. Tenn. Acad. Sci., Vol 48, No. 3 (1973) pp 106-111.

Brown, Bryce C., An Annotated Check List of the Reptiles and Amphibians of Texas (Waco: Baylor Univ. Press, 1950), 257 pp.

Cole, A. C., "A Guide to the Ants of the Great Smoky Mountains National Park, Tennessee," Amer. Midl. Natur., Vol 24 (1940), pp 1-87.

DeLong, D. M., "The Leafhoppers or Jassoidea of Tennessee," Tennessee State Board of Entomol. Bull., Vol 5 (1916), pp 1-113.

Gentry, Glenn, "An Annotated Check List of the Amphibians and Reptiles of Tennessee," Journal of the Tennessee Academy of Sci., Vol 30 (1955), pp 168-76, and Vol 31 (1956), pp 242-51. Knoxville.

Huheey, James E. and Arthur Stupka, Amphibians and Reptiles of Great Smoky Mountains National Park (Knoxville: U. of Tennessee Press, 1967).

Kellogg, Remington, "Annotated List of Tennessee Mammals," Proc. U. S. Nat. Mus., Vol 86, No. 3051 (1959), pp 245-303.

Kuhne, Eugene R., A Guide to the Fishes of Tennessee and the Mid-south, (Nashville: Tenn. Dept. Cons., 1939), 124 pp. Keys and descriptions for most of the fishes found in Tennessee. Illustrated.

Parker, Malcom V., "The Amphibians and Reptiles of Reelfoot Lake and Vicinity, With a Key for the Separation of Species and Subspecies," Tenn. Acad. Sci. Jour., Vol 14, No. 1 (1939), pp 72-101.

- Quarterman, E., "Major Plant Communities of Tennessee Cedar Glades," Ecol., Vol 31 (1950), pp 234-254.
- Severinghaus, W. D. and L. E. Beasley, "A Survey of the Microtine and Zapodid Rodents of West Tennessee," J. Tenn. Acad. Sci., Vol 48, No. 4 (1973), pp 129-133.
- Shaver, Jesse M., Ferns of Tennessee with the Allies Excluded (Nashville: George Peabody College for Teachers, 1954).
- Sinclair, Ralph, Will Hon and Robert B. Ferguson, Amphibians and Reptiles of Tennessee (Nashville: Tennessee Game and Fish Commission, 1965).
- Stupka, Arthur, Trees, Shrubs and Woody Vines of Great Smoky Mountains National Park (The University of Tennessee Press, 1964).
- Wright, M. and L. Berner, "Notes on the Mayflies of Eastern Tennessee," J. Tenn. Acad. Sci., Vol 24 (1949), pp 287-298.
- Texas*
- Bailey, V., Biological Survey of Texas, N. Amer. Fauna, Vol 25 (1905), pp 9-222.
- Beaty, H. E., "A Checklist of Flora and Fauna in Central and West Bell County, Texas," unpublished manuscript.
- Blair, W. F., "The Biotic Provinces of Texas," Tex. J. Sci., Vol 2 (1950), pp 93-117.
- Blair, W. F. and C. E. Miller, Jr., "Mammals of the Sierra Viega Region, Southwestern Texas, With Remarks on the Biogeographic Position of the Region," Tex. J. Sci., Vol 1 (1949), pp 67-92.
- Blair, W. Frank, "The Biotic Provinces of Texas," Texas J. Sci., Vol 2 (1950), pp 93-117.
- Brown, Bryce C., An Annotated Check List of the Reptiles and Amphibians of Texas (Waco, Texas: Baylor University Press, 1950).
- Correll, D. S., and M. C. Johnston, Manual of Vascular Plants of Texas (Renner, Texas: Texas Res. Found., 1970), 1881 pp.
- Davis, William B., The Mammals of Texas, Austin, Texas: Texas Game and Fish Comm., Bull. 27 (1960), 252 pp.
- Dixon, Keith L., "Ecological and Distributional Relations of Desert Scrub Birds of Western Texas," Condor, Vol 61 (1959), pp 397-409.

- Easteria, David A., The Amphibians and Reptiles of Big Bend National Park, Texas (Big Bend Natural History Association, 1975).
- Gould, F. W., Texas Plants: A Checklist and Ecological Summary, Texas A & M Univ., Texas Agric. Exp. Sta., College Station, Texas, MP-585/Rev (1975).
- Gunter, G., "Studies on Marine Fishes of Texas," Publ. Inst. Mar. Sci. Univ. Tex., Vol 1 (1945), pp 1-190.
- Harcombe, P. A. and P. L. Marks, "Understory Structure of a Mesic Forest in Southeast Texas," Ecology, Vol 58, No. 5 (1977), pp 1144-1151.
- Hubbs, Clark, Key to the Freshwater Fishes of Texas, Unpublished (1970).
- Johnson, C., "The Danselflies (Zygoptera) of Texas," Bull. Fla. State Mus. Biol. Sci., Vol 16 (1972), pp 55-128.
- Knapp, Frank T., Fishes Found in the Fresh Waters of Texas (Brunswick, Brunswick, Georgia: Ragland Studio and Litho. Printing Co., 1953), viii, 166 pp. A description of the fishes of Texas with range and keys. Illustrated.
- McLeod, C. A., "The Big Thicket Forest of East Texas," Tex. J. Sci., Vol 23 (1971), pp 221-233.
- Oberholser, Harry C., The Bird Life of Texas (Univ. Texas Press, 1974).
- Rare Plant Study Center, Rare and Endangered Plants Native to Texas, Austin: Univ. Texas, Rare Plant Study Center, 1974.
- Raun, G. G. and F. R. Gehlbach, Amphibians and Reptiles in Texas, Dallas Mus. Nat. Hist., Bull. 2 (1972), 132 pp.
- Raun, Gerald G., A Guide to Texas Snakes, Austin: Texas Memorial Mus. Museum Notes No. 9 (1965).
- Roberts, J. D. and R. L. Packard, "Comments on Movements, Home Range and Ecology of the Texas Kangaroo Rat, *Depodomys elator* Merriam," J. of Mammalogy, Vol 54, No. 4 (1973).
- Rogers, James S., "Species Density and Taxonomic Diversity of Texas Amphibians and Reptiles," Systematic Zoology, Vol 25, No. 1 No. (1976).
- Schmidly, David, "Population Variation in *Dipodomys Ordii* From Western Texas," J. of Mammalogy, Vol 52, No. 1 (1971).

Schmidly, David J., The Mammals of Trans-Pecos Texas (College Station: Texas A & M Univ. Press, 1978), 240 pp.

Teer, J. G., J. W. Thomas and E. A. Walker, "Ecology and Management of White-Tailed Deer in the Land Basin of Texas," Wildl. Monogr., Vol 15 (1965), 65 pp.

Tharp, Benjamin, Texas Range Grasses (Austin: University of Texas Press, 1952).

Ueckert, Darrell N., Bodine, M. C. and Spears, B. M., "Population Density and Biomass of the Desert Termite *Gnathamitermes Tubiformans* (Isoptera Termitidae) in a Shortgrass Prairie: Relationship to Temperature and Moisture," Ecology, Vol 57, No. 6 (1976), pp 1273-1280.

Wills, Mary M. and H. S. Irwin, Roadside Flowers of Texas (Austin: Univ. Texas Press, 1961).

Wolfe, L. R., W. M. Pulich and J. A. Tucker, Checklist of the Birds of Texas (Waco, Texas: Texas Ornithological Society, 1974).

Utah

Durrant, S. D., Mammals of Utah, Univ. Kansas Publs., Mus. Nat. Hist., Vol 6 (1952), pp 1-549.

Ellison, L., "Subalpine Vegetation of the Wasatch Plateau, Utah," Ecol. Monogr., Vol 24 (1954), pp 84-184.

Fautin, Reed W., "Biotic Communities of the Northern Desert Shrub Biotic in Western Utah," Ecol. Mono., Vol 16 (1946), pp 251-310.

Flowers, Seville, Mosses: Utah and the West, ed. Arthur Holmgren (Provo, Utah: Brigham Young Univ. Press, 1973), 567 pp.

Hayward, C. Lynn, "Biotic Communities of the Southern Wasatch and Uinta Mountains, Utah," Great Basin Nat., Vol 6 (1945), pp 1-124.

Hayward, C. Lynn, "Biotic Communities of the Wasatch Chaparral, Utah," Ecol. Mono., Vol 18 (1948), pp 473-506.

Hayward, C. Lynn, "Alpine Biotic Communities of the Uinta Mountains, Utah," Ecol. Mono., Vol 22 (1952), pp 93-120.

Hirth, N. F., R. C. Pendleton and A. C. Ring, "Dispersal of Snakes from a Hibernaculum in Northwestern Utah," Ecology, Vol 50, No. 2, (1969).

Porter, R. D., C. M. White and R. J. Erwin, "The Peregrine Falcon in Utah, Emphasizing Ecology and Competition With the Prairie Falcon," Brigham Young Univ. Sci. Bull. Biol. Ser., Vol 18, No. 1 (1933), pp 1-74.

Sigler, Wm. F. and R. R. Miller, Fishes of Utah (Utah State Dept. Fish and Game, 1963), 203 pp. Description and habits of the fishes of Utah.

Slade, Norman A. and David B. Balph, "Population Ecology of Uinta Ground Squirrels," Ecology, Vol 55, No. 5 (1974).

Treshow, Michael and Stanley L. Welsh, Guide to the Woody Plants of Utah (Boulder, CO.: Pruett Press, Inc., 1964).

Vermont

Osgood, F. L., Jr., "The Mammals of Vermont," Jour. Mammal., Vol 19 (1938), pp 435-441.

Flynn, Nellie F., Flora of Burlington and Vicinity: A List of the Fern and Seed Plants Growing without Cultivation (Burlington, Vt.: Botanical Laboratories, University of Vermont, 1935).

Virginia

Bobb, M. L., "The Life History of Gerris Canaliculatus Sax in Virginia (Hemiptera: Gerridae)," Va. J. Sci., N. S., Vol 2 (1951), pp 102-108.

Bobb, M. L., The Aquatic and Semiaquatic Hemiptera of Virginia, Va Polytech. Inst. State Univ. Res. Div. Bull. 87 (1974), 195 pp.

Burton, George W. and Eugene P. Odum, "The Distribution of Stream Fish in the Vicinity of Mountain Lake, Virginia," Ecol. Vol 26 (1945), pp 182-194.

Handley, C. O., Jr. and C. P. Patton, Wild Mammals of Virginia (Richmond, Va.: Comm. Game and Inland Fish, 1947).

Massey, A. B., The Ferns and Fern Allies of Virginia, Bulletin of the Virginia Polytechnic Institute, 37, No. 7 (May 1944).

Mitchell, Joseph C., The Snakes of Virginia (Richmond: reprinted from Virginia Wildlife, Commission of Game and Inland Fisheries, February and April, 1974).

Mossmann, Wilt, E. C. Lodd and H. N. McCutcheon, A Biological Survey of the Rappahannock River, Virginia, Va. Fish. Lab. Spec. Sci. Rep. 6 (1952), 221 pp.

Washington

- Brown, E. R., The Black-Tailed Deer of Western Washington, Olympia: Wash. State Game Dept. Biol. Bull. No. 13 (1961).
- Dalquest, Walter W., The Mammals of Washington, Univ. Kansas Publ., Mus. Nat. Hist., Vol 2 (1948), pp 1-444.
- Daubenmire, R., Steppe Vegetation of Washington, Wash. Agric. Exp. Stn. Tech. Bull. No. 62 (1970), 131 pp.
- Dawson, W. L. and J. H. Bowles, The Birds of Washington, 2 vols. (Seattle: Occidental Pub. Co., 1909).
- Douglas, G. W., "The Alpine, Subalpine Flora of the North Cascade Range, Washington," Wasmann J. Biol., Vol 29 (1971), pp 129-168.
- Howard, G. E., Lichens of the State of Washington (Seattle: Univ. Wash. Press, 1950), 191 pp.
- Jewett, S. G., W. P. Taylor, W. T. Shaw and J. W. Aldrich, Birds of Washington State, (Seattle: Univ. Wash. Press, 1953).
- Larrison, Earl J. and Klaus G. Sonnenberg, Washington Birds, Their Location and Identification (Seattle Audubon Soc., 1968).
- Merritt, J. F., "Factors Influencing the Local Distribution of *Peromyscus maniculatus* and *Perognathus parvus* in Eastern Washington," J. of Mammalogy, Vol 55, No. 1 (1974).
- Schultz, Leonard P., Keys to the Fishes of Washington, Oregon and Closely Adjoining Regions, Univ. Wash. Publ. Zool. Vol 2, No. 4 (1936), pp. 103-228. Useful for identification of both marine and freshwater fishes of this region.

West Virginia

- Green, N. Bayard, The Amphibians and Reptiles of West Virginia, Their Identification, Habits and Distribution (Huntington: Marshall College, 1954).
- Kellogg, Remington, "Annotated List of West Virginia Mammals," Proc. U. S. Nat. Mus., Vol 84, No. 3022, pp 443-479.
- Strausbaugh, P. D. and E. L. Core, Flora of West Virginia, Parts 1-4, Morgantown: West Virginia Univ. Bulletin, 1952-64.
- Wilson, L. W. and J. E. Friedel "A List of Mammals Collected in West Virginia," Proc. West Va. Acad. Sci. for 1941, Vol 15 (West Va. Univ. Bull., Ser. 42, Nos. 8-11), pp 85-92.

Wisconsin

- Barger, N. R., Wisconsin Mammals, Wis. Cons. Dept. Publ. 315-51 (1951), 54 pp.
- Birge, E. A. and C. Juday, The Inland Lakes of Wisconsin. The Plankton, I. Its Quantity and Chemical Composition, Wis. Geol. and Nat. Hist. Bull. No. 64, Sci. Ser. No. 13 (1927), pp 1-222.
- Bray, J. R. and J. T. Curtis, "An Ordination of the Upland Forest Communities of Southern Wisconsin," Ecol. Mono., Vol 27 (1957) pp 325-349.
- Bray, R. and J. T. Curtis, "An Ordination of Upland Forest Communities of Southern Wisconsin," Ecol. Monographs, Vol 27 (1957), pp 325-349.
- Brown, R. T. and J. T. Curtis, The Upland Conifer-Hardwood Forests of Northern Wisconsin, Ecol. Mono., Vol 22 (1952), pp 217-234.
- Curtis, J. T., The Vegetation of Wisconsin (Madison: Univ. Wis. Press, 1959), 657 pp.
- Curtis, J. T. and R. P. McIntosh, "The Upland Forest Continuum in the Prairie-Forest Border Region of Wisconsin," Ecology, Vol 32 (1951), pp 476-496.
- Dickinson, W. E., Amphibians and Turtles of Wisconsin, Milwaukee Public Mus., Popular Science Handbook Series, No. 10 (1965).
- Dickinson, W. E., Field Guide to the Lizards and Snakes of Wisconsin, Milwaukee: Milwaukee Public Mus., Popular Science Handbook Series No. 2 (1949).
- Dickinson, W. E., "The Mosquitoes of Wisconsin," Milwaukee Pub. Mus. Bull., Vol 8 (1944), pp 269-365.
- Greene, C. W., The Distribution of Wisconsin Fishes (Madison: State of Wis. Conser. Comm., 1935), 235 pp.
- Gromme, Owens J., Birds of Wisconsin (Univ. Wis. Press, 1963).
- Hamerstrom, F. N., Jr., A Study of Wisconsin Prairie Chicken and Sharp-Tailed Grouse, Wilson Bull., Vol 5 (1939), pp 105-120.
- Hilsenhoff, W. L. and R. P. Narf, "Ecology of Chironomidae, Chaoboridae, and Other Benthos in Fourteen Wisconsin Lakes," Ann. Entomol. Soc. Amer., Vol 61 (1968), pp 1173-1181.
- Howmiller, R. P., "Studies on Aquatic Oligochaeta in Inland Waters of Wisconsin," Trans. Wis. Acad. Sci. Arts Lett., Vol 62 (1974), pp 337-350.

Jackson, H. H. T., Mammals of Wisconsin (Madison: Univ. Wisc. Press, 1961), 504 pp.

Knudsen, G. J., "Preliminary Survey of Turkey Vultures in Wisconsin," Passenger Pigeon, Vol 38 (1976), pp 100-105.

Leopold, A., "The Distribution of Wisconsin Hares," Trans. Wis. Acad. Sci. Arts Lett., Vol 37 (1945), pp 1-14.

Longridge, J. L. and W. L. Hilsenhoff, "Annotated List of Trichoptera (Caddisflies) in Wisconsin," Trans. Wis. Acad. Sci., Arts & Lett., Vol 61 (1973), pp 173-183.

Knight, Dennis N., "A Quantitative Analysis of Wisconsin Forest Vegetation on the Basis of Plant Function and Gross Morphology," Ecology, Vol 50, No. 2 (1969).

Novitzski, R. P., Improvement of Trout Streams in Wisconsin by Augmenting Low Flows with Ground Water, U. S. Department of the Interior, Geological Survey, in cooperation with Wisconsin Department of Natural Resources, Geological Survey Water-Supply Paper 2017, Washington, D. C., 1973.

Pope, T. E. B. and W. E. Dickinson, The Amphibians and Reptiles of Wisconsin, Milwaukee: Bull. of the Public Mus. of the City of Milwaukee, Vol 8, No. 1 (1928).

Schmidt, F. J. W., "Mammals of Western Clark County, Wisconsin," Jour. Mammal., Vol 12, No. 2 (1931), pp 99-117.

Tryon, R. M., Jr. et al., The Ferns and Fern Allies of Wisconsin, 2nd ed. (Madison, Wisc.: University of Wisconsin Press, 1953).

Zavitkovski, J., "Ground Vegetation Biomass, Production and Efficiency of Energy Utilization in Some Northern Wisconsin Forest Ecosystems," Ecology, Vol 57, No. 4 (1976).

Wyoming

Bailey, Vernon, "Animal Life of Yellowstone Park," Sierra Club Bull., Vol 12 (No. 4 (1927), pp 333-345.

Brown, Larry, "Population Dynamics of the Western Jumping Mouse During a Four Year Study," J. of Mammology, Vol 51, No. 4 (1970).

Long, C. A., The Mammals of Wyoming, Univ. Kansas Publs., Mus. Natur. Hist., Vol 14, No. 8 (1965), pp 493-758.

Negus, N. C. and J. S. Findley, "Mammals of Jackson Hole, Wyoming,"
Jour. Mammal., Vol 40 (1959), pp 371-381.

Simon, James R., Wyoming Fishes, Bull. Wyo. Game and Fish Dept.,
Cheyenne. No. 4 (1946), 129 pp. Description of Wyoming fishes
with keys. Illustrated.

4. Non-U.S. Biota

- Anderson, S., Mammals of Chihuahua, Taxonomy, and Distribution, Bull. Amer. Mus. Nat. Hist., Vol 148 (1972), pp 153-410.
- Baker, R. H. and J. K. Greer, Mammals of the Mexican State of Durango, Publ. Mus., Michigan State Univ., Biol. Ser., Vol 2 (1962), pp 25-154.
- Baker, Rollin H., Mammals of Coahuila, Mexico, Univ. Kansas Publ., Mus. Nat. Hist., Vol 9, No. 7 (1956), pp 125-335.
- Banfield, A. W. F. Mammals of Banff National Park, Alberta. Nat'l. Mus. Canada, Bull. 159 (1958).
- Banfield, A. W. F., The Mammals of Canada, (Toronto: Univ. Toronto Press, 1974), xxv + 438 pp.
- Bere, R. M., The Wild Mammals of Uganda (London: Longmans, 1962), 148 pp.
- Bleakney, Sherman, "The Amphibians and Reptiles of Nova Scotia," Canadian Field-Naturalist, Vol 66 (1952), pp 125-29.
- Bleakney, Sherman, A Zoogeographical Study of the Amphibians and Reptiles of Eastern Canada Ottawa: Natl. Mus. of Canada. Bull. No. 155, Biol. Ser. 54 (1958).
- Boivin, B., "Flora of the Prairie Provinces of Canada," Phytologia, Vol. 23 (1972), pp 1-140.
- Bond, J., A Field Guide to the Birds of the West Indies (Boston: Houghton Mifflin, 1971).
- Comstock, William Phillips, Insects of Porto Rico and the Virgin Islands. Rhopalocera or Butterflies. Scientific Survey of Porto Rico and the Virgin Islands, Volume 12, Part 4, (New York, New York: New York Academy of Sciences, 1944).
- Cook, Francis R., An Analysis of the Herpetofauna of Prince Edward Island, Ottawa: Natl. Mus. of Canada, Bull. No. 212, Biol. Ser. 75 (1967).
- Cowan, I. McT. and C. J. Guiguet, The Mammals of British Columbia, McDiarmid, Victoria: British Columbia Prov. Mus. Handbook No. 11 (1960).
- Dalquest, Walter W., Mammals of the Mexican State of San Luis Potosi, Louisiana St. Univ. Stud., Biol. Ser., Vol 1 (1953), pp 1-229.

- DeSchaunensee, R. M., The Birds of Colombia and Adjacent Areas of South and Central America (Norbeth: Livingston Publ. Co., 1964).
- DeSchaunensee, R. M., A Guide to the Birds of South America, (Wynnewood, Pa.: Livingston, 1970).
- Diamond, J. M., "Distributional Ecology of New Guinea Birds," Science, Vol 179 (1973), pp 759-769.
- Gillard, E. T., "The Birds of Mt. Auyantepai, Venezuela," Bull. Amer. Mus. Nat. Hist., Vol 77 (1941), pp 439-508.
- Godfrey, W. E., The Birds of Canada, Natl. Mus. Canada Bull. 203, Biol. Ser. 73 (1966).
- Goodwin, G. G., Mammals of Costa Rica, Bull. Amer. Mus. Nat. Hist., Vol 87 (1946), pp 473.
- Hall, E. R. and W. W. Dalquest, The Mammals of Vera Cruz, Univ. Kansas Pubs., Mus. Nat. Hist., Vol 14 (1963), pp 165-362.
- Heller, E., Mammals of the Galapagos Archipelago, Exclusive of the Cetacea, Proc. Calif. Acad. Sci., Vol 3 (1904), pp 233-249.
- Holland, George P., The Siphonaptera of Canada, Tech. Bull. No. 70, Canada Dept. Agric. (1945).
- Hooper, E. T., "Notes on Mammals of Western Mexico," Occ. Pap. Mus. Zool. Univ. Mich., Vol 565 (1955), pp 1-26.
- Huey, L. M., "The Mammals of Baja, California," Trans. San Diego Soc. Nat. Hist., Vol 13 (1963), pp 85-168.
- Logier, E. B. S., The Frogs, Toads, and Salamanders of Eastern Canada (Toronto: Clarke, Irwin, 1952).
- Logier, E. B. S., The Snakes of Ontario (Toronto: U. of Toronto Press, 1958).
- Moreau, R. E., The Bird Faunas of Africa and its Islands (New York: Academic Press, 1966).
- Parker, Gerald, "Distribution and Densities of Wolves Within Barren Ground Caribou Range in Northern Mainland and Canada," J. of Mammalogy, Vol 54, No. 2 (1973).
- Philibosian, R. and J. A. Yntema, Annotated Checklist of Birds, Mammals, Reptiles, and Amphibians of the Virgin Islands and Puerto Rico (1977). Information Services, P. O. Box 305, Fredericksted, St. Croix, U. S. Virgin Islands 00840.

- Rand, A. L., Mammals of the Eastern Rockies and Western Plains of Canada, Natl. Mus. Canada, Bull. 108 (1948).
- Rand, A. L. and E. T. Gilliard, Handbook of New Guinea Birds (London: Weidenfeld and Nicolson, 1967).
- Ride, W. D. L., A Guide to the Native Mammals of Australia (Melbourne: Oxford Univ. Press, 1970).
- Schwartz, Albert and Richard Thomas, Checklist of West Indian Amphibians and Reptiles, Pittsburgh: Carnegie Museum of Nat. Hist., Special Pub. No. 1 (1975).
- Scott, W. B. and E. J. Crossman, Freshwater Fishes of Canada, Fish. Res. Board Can. Bull. 184 (1973), 966 pp.
- Seton, E. T., The Birds of Manitoba, Proc. U. S. National Mus., Vol 13 (1890), pp 457-643.
- Smith, Hobart M. and Edward H. Taylor, Herpetology of Mexico: Annotated Checklists and Keys to the Amphibians and Reptiles (Ashton, Md.: Eric Lundberg 1966). (A reprint of Bulletins 187, 194, and 199 of the U. S. National Museum of Natural History with a list of subsequent taxonomic innovations.)
- Tate, G. H. H., The Mammals of the Guiana Region, Bull. Amer. Mus. Nat. Hist., Vol 76 (1939), pp 151-229.
- Wetmore, A., The Birds of the Republic of Panama, Part 1, Smithsonian Misc. Coll. No. 150 (1965).
- Wetmore, A., The Birds of Panama, Part 2; Columbidae (Pigeons) to Picidae (Woodpeckers), Smithsonian Misc. Coll. No. 150 (1968).
- Wetmore, A., The Birds of Panama, Part 3, Smithsonian Misc. Coll. No. 150 (1972), pp 1-631.

APPENDIX B:

LIST OF MUSEUMS AND SPECIALISTS

Alabama

1. Alabama Department of Conservation and Natural Resources
Game and Fish Division
64 Union Street
Montgomery, Alabama 36104
2. University of Alabama
Museum of Natural History
University, Alabama 34586
3. University of South Alabama
Natural History Collection
Mobile, Alabama 36688

Alaska

1. Alaska Department of Fish and Game
Division of Game
1300 College Road
Fairbanks, Alaska 99701
2. Naval Arctic Research Laboratory
Barrow, Alaska 99723
3. University of Alaska Museum
Fairbanks, Alaska 99701

Arizona

1. Department of Zoology
Arizona State University
Tempe, Arizona 85281
2. Grand Canyon National Park
Box 129
Grand Canyon, Arizona 86023
4. Northern Arizona University
Museum of Vertebrates
Box 5640
Flagstaff, Arizona 86001
5. Southwestern Research Station
Portal, Arizona 85632

6. Department of Biological Sciences
University of Arizona
Tuscon, Arizona 85721

Arkansas

1. Division of Biological Sciences
Arkansas State University
State University, Arkansas 72467
2. Zoology Department
University of Arkansas
Fayetteville, Arkansas 72701
3. Arkansas Game and Fish Commission
Game and Fish Building
Little Rock, Arkansas 72201

California

1. California Academy of Sciences
Golden Gate Park
San Francisco, California 94118
2. San Diego Natural History Museum
Balboa Park
P.O. Box 1390
San Diego, California 92112
3. United States Forest Service, San Joaquin Experimental Range
Coarsegold, California 93614
4. Museum of Vertebrate Zoology
University of California
Berkeley, California 94720
5. Museum of Wildlife and Fisheries Biology
University of California
Davis, California 95616
6. Los Angeles County Museum
Los Angeles, California

Colorado

1. University of Colorado Museum
University of Colorado
Boulder, Colorado 80302

2. U.S. Bureau of Sport Fisheries and Wildlife
Denver Collection of the Bird and Mammal Laboratories
Building 45
Federal Center
Denver, Colorado 80225
3. Department of Zoology and Entomology
Colorado State University
Fort Collins, Colorado 80521
4. Denver Museum of Natural History
City Park
Denver, Colorado 80205

Connecticut

1. Museum of Natural History
University of Connecticut
Storrs, Connecticut 06268
2. Peabody Museum of Natural History
Yale University
New Haven, Connecticut

Delaware

1. Delaware Museum of Natural History
P.O. Box 3937
Greenville, Delaware 19807
2. Department of Entomology and Applied Ecology
University of Delaware
Newark, Delaware 19711

District of Columbia

1. National Museum of Natural History
Smithsonian Institute
Washington, DC 20560

Florida

1. The Florida State Museum
University of Florida
Gainesville, Florida 32611
2. Archbold Biological Station
Rt. 2
Box 380
Lake Placid, Florida 33852

3. Biology Department
University of South Florida
Tampa, Florida 33620
4. Tall Timbers Research Station
Rt. #1
Box 160
Tallahassee, Florida 32303

Georgia

1. Museum of Vertebrate Zoology
University of Georgia
Athens, Georgia 30602

Hawaii

1. Bernice P. Bishop Museum
Box 6037
Honolulu, Hawaii 96818

Idaho

1. Department of Biology
Idaho State University
Pocatello, Idaho 83201

Illinois

1. Field Museum of Natural History
Chicago, Illinois 60605
2. Illinois Natural History Survey
University of Illinois
Urbana, Illinois 61801
3. Illinois State Museum
Springfield, Illinois 62706
4. Museum of Natural History
University of Illinois
Urbana, Illinois 61801
5. Cooperative Wildlife Research Laboratory
Southern Illinois University
Carbondale, Illinois

Indiana

1. Joseph Moore Museum
Earlham College
Richmond, Indiana 47374
2. Wildlife Laboratory Collection
Department of Forestry and Conservation
Purdue University
Lafayette, Indiana 47907
3. Department of Life Sciences
Indiana State University
Terre Haute, Indiana 47800

Iowa

1. Museum of Zoology
Iowa State University
Ames, Iowa 50010
2. Museum of Natural History
University of Iowa
Iowa City, Iowa 52240

Kansas

1. Museum of the High Plains
Fort Hays Kansas State College
Hays, Kansas 67601
2. Museum of Natural History
University of Kansas
Lawrence, Kansas 66045

Kentucky

1. School of Biology
University of Kentucky
Lexington, Kentucky 40506

Louisiana

1. Museum of Zoology
Louisiana State University
Baton Rouge, Louisiana 70803

2. Systematic and Environmental Biology Laboratory
Herbert Center
Riverside Research Laboratories
Route 1
Box 46-B
Belle Chasse, Louisiana 70037

Maine

1. School of Forest Resources
University of Maine
Orono, Maine 04473

Massachusetts

1. Museum of Comparative Zoology
Harvard University
Oxford Street
Cambridge, Massachusetts 02138
2. Department of Forestry and Wildlife Management
University of Massachusetts
Amherst, Massachusetts 01002
3. Museum of Zoology
University of Massachusetts
Amherst, Massachusetts 01002

Michigan

1. The Museum
Michigan State University
East Lansing, Michigan 48823
2. Museum of Zoology
University of Michigan
Ann Arbor, Michigan 48104
3. Museum of Natural History
Wayne State University
Detroit, Michigan 48202

Minnesota

1. The Science Museum of Minnesota
30 E. Tenth
St. Paul, Minnesota 55101
2. Department of Entomology, Fisheries, and Wildlife
University of Minnesota
St. Paul, Minnesota 55108

3. James Ford Bell Museum of Natural History
University of Minnesota
Minneapolis, Minnesota 55455

Mississippi

1. The Fannye A. Cook Memorial
Mississippi Museum of Natural Science
Division of Game and Fish Commission
111 N. Jefferson Street
Jackson, Mississippi 39202

Missouri

1. Department of Fisheries and Wildlife
University of Missouri
Columbia, Missouri 65201

Montana

1. Wildlife Laboratory
Department of Fish and Game
Montana State University
Bozeman, Montana 59715
2. Department of Zoology
University of Montana
Missoula, Montana 59801

Nebraska

1. Vertebrate Museum
Kearney State College
Kearney, Nebraska 68847
2. State Museum
14th and U Street
University of Nebraska
Lincoln, Nebraska 68508

Nevada

1. Nevada State Museum
600 N. Carson Street
Carson City, Nevada 89701
2. Department of Biological Sciences
University of Nevada, Las Vegas
Las Vegas, Nevada 89154

New Hampshire

1. Dartmouth College Museum
Hanover, New Hampshire 03755

New Jersey

1. Museum of Natural History
Princeton University
Princeton, New Jersey 08540

New Mexico

1. Natural History Museum
Eastern New Mexico University
Portales, New Mexico 88130
2. Department of Biology
New Mexico State University
Las Cruces, New Mexico 88003
3. Museum of Southwestern Biology
University of New Mexico
Albuquerque, New Mexico 87106

New York

1. American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024
2. Section of Ecology and Systematics
Langmuir Laboratory
Cornell University
Ithaca, New York 14850
3. New York State Museum and Science Service
Albany, New York 12224
4. College of Environmental Science and Forestry
State University of New York
Syracuse, New York 13210
5. Wildlife Research Laboratory
New York State Department of Environmental Conservation
Delmar, New York 12054

North Carolina

1. North Carolina State Museum
P.O. Box 27647
Raleigh, North Carolina 27611
2. Department of Zoology
North Carolina State University
Raleigh, North Carolina 27607

North Dakota

1. Department of Biology
University of North Dakota
Grand Forks, North Dakota 58201

Ohio

1. Cleveland Museum of Natural History
Wade Oval
University Circle
Cleveland, Ohio 44106
2. Museum of Zoology
Ohio State University
Columbus, Ohio 43210

Oklahoma

1. Museum of Natural and Cultural History
Oklahoma State University
Stillwater, Oklahoma 74074
2. Stovall Museum of Science and History
University of Oklahoma
Norman, Oklahoma 73069

Oregon

1. Museum of Natural History
Oregon State University
Corvallis, Oregon 97331
2. Museum of Natural History
University of Oregon
Eugene, Oregon 97403

Pennsylvania

1. Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213
2. Forest Resources Laboratory
Pennsylvania State University
University Park, Pennsylvania 16802
3. Philadelphia Academy of Natural Sciences
19th and the Parkway
Philadelphia, Pennsylvania 19103

Puerto Rico

1. Department of Biology
University of Puerto Rico
Mayaguez, Puerto Rico 00708

South Carolina

1. Charleston Museum
121 Rutledge Avenue
Charleston, South Carolina 29401

South Dakota

1. Entomology - Zoology Department
South Dakota State University
Brookings, South Dakota 57006

Tennessee

1. Biology Department
Memphis State University
Memphis, Tennessee 38111

Texas

1. Dallas Museum of Natural History
P.O. Box 26193
Fair Park Station
Dallas, Texas 75226
2. Fort Worth Museum of Science and History
1501 Montgomery Street
Fort Worth, Texas 76107
3. Texas Cooperative Wildlife Collections
Texas A&M University
College Station, Texas 77843

4. Texas Natural History Collection
Texas Memorial Museum
University of Texas
Austin, Texas 78705
5. The Museum
Texas Tech University
Lubbock, Texas 79409
6. Museum of Arid Land Biology
University of Texas at El Paso
El Paso, Texas 79968

Utah

1. Life Sciences Museum
Brigham Young University
Provo, Utah 84602
2. Department of Biology
University of Utah
Salt Lake City, Utah 84112

Vermont

1. Department of Zoology
University of Vermont
Burlington, Vermont 05401

Virginia

1. Center for Systematics Collections
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Washington

1. Puget Sound Museum of Natural History
University of Puget Sound
Tacoma, Washington 98416
2. Thomas Burkes Memorial Washington State Museum
University of Washington
Seattle, Washington 98195
3. Department of Biology
Walla Walla College
College Place, Washington 99324

4. Charles R. Conner Museum
Washington State University
Pullman, Washington 99163

West Virginia

1. Conservation Commission for West Virginia
Marshall University
Huntington, West Virginia 25701

Wisconsin

1. Milwaukee Public Museum
800 West Wells
Milwaukee, Wisconsin 53233
2. Zoological Museum
Noland Zoology Building
University of Wisconsin
Madison, Wisconsin 53706
3. The Museum of Natural History
University of Wisconsin
Stevens Point, Wisconsin 54481

Wyoming

1. The Museum of Zoology
University of Wyoming
Laramie, Wyoming 82071

APPENDIX C:

PRISM METHOD OF FOREST SAMPLING

The following is from a paper by John F. Bell and Lucien B. Alexander, "Application of the Variable Plot Method of Sampling Forest Stands," Oregon State Board of Forestry, Salem, Oregon (1957), 22 pp.

INTRODUCTION

The variable plot method of sampling a forest stand was developed in Europe by Walter Bitterlich (1). It was introduced to American foresters by Dr. L. R. Grosenbaugh (2) in 1952.

Although several papers have been written covering the principle of the variable plot method of sampling a forest stand, little has been written about its field application. This paper is designed for the practicing forester who is interested primarily in the use of the technique for cruising and other inventory work.

Determination of the ratio of basal area or volume to land area with the fixed plot size method of sampling, requires that trees inside the plot boundary be measured and tallied and those outside ignored. The variable plot method in actuality is merely another way of determining which trees to measure and tally. Those trees which are large enough to subtend a predetermined angle are tallied and used to determine the ratio of basal area or volume to land area, while those too small or too far away are ignored.

The variable plot method is a simpler, more rapid method of determining basal area and volume per acre than the conventional plot or strip methods. It reduces the personal error involved since the need to measure plot radii or strip width is eliminated and accurate diameter measurements are not necessary. The variable plot method reduces total field cruising time by approximately one third. The probability that any tree will be sampled is proportional to its basal area. Thus, a greater proportion of cruising time is spent on the larger trees. Since there is a saving in field cruising time and since more time is spent on the larger trees, the accuracy of defect and grade determinations is increased.

The reader will find in the appendix an abstract on the theory of the variable plot method of sampling a forest stand.

- (1) Bitterlich, W. Die Winkelzahlprobe. Allgemeine Forst - und Holzwirtschaftliche Zeitung 59(1/2): 4-5. 1948.
- (2) Grosenbaugh, L. R. Plotless Timber Estimates - New, Fast, Easy. Journal of Forestry 50: 32-37. 1952.

THE WEDGE PRISM

The wedge prism is a precise optical instrument which bends light rays establishing the reference or critical angle. Wedge prisms ground to specifications, as developed by the consulting firm of Mason, Bruce and Girard, can be purchased through Bausch and Lomb, 7 Northwest 9th Avenue, Portland, Oregon, or through Kollmorgan Optical Corporation, Northampton, Massachusetts. The former company does not produce prisms which can be interchanged without a change in basal area factors. Their prisms cost about \$2.50 each. The latter company produces prisms with exact factors such as 20, 25, or 30, but the prisms are \$15.00 each and must be purchased in quantities.

FUNCTIONS OF WEDGE

What Prism Diopter to Use

One prism diopter is equal to a right angle displacement of one unit per 100 equal units distance. The general rule to follow is to select a prism diopter that will give an average tree count of four to six trees per observation point. It is best to employ the same diopter in any one given stand. The smaller the trees, the lower the diopter. The larger the trees, the higher the diopter. The more open the stand, the smaller the diopter. The more dense the stand, the larger the diopter. A compromise between size and density, with size the dominant factor, determines the diopter to use.

Listed below are some examples for the Pacific Northwest:

2-3 Diopter - small immature stands

4 Diopter - large immature Douglas fir stands
and selectively cut Ponderosa Pine.

5 Diopter - second growth Douglas fir sawtimber
and uncut Ponderosa Pine.

6 Diopter - old growth Douglas fir or Cascade
Mountain mixed sawtimber.

8 Diopter - dense old growth Douglas fir,
Redwood, or other very large
sawtimber.

The Wedge Prism Basal Area Factor

The wedge prism would be of little use to the forester in determining stocking density or in the estimation of volume without the basal

area factor. This factor, when multiplied by the average number of trees per observation point, will result in square feet per acre occupied by tree stems.

Determination of the Basal Area Factor

The basic method followed in determining a basal area factor is relatively simple. Place a rectangular target of any convenient width (1'-2'-3') on a vertical surface. The wedge is first moved away from the target until the target image is completely displaced so that one side of the image as seen over the prism is aligned with the other side as seen through the prism. The distance at which this occurs is measured in feet. Next the wedge is moved toward the target until the displacement occurs again. Again the distance is measured.

An average distance calculated from six such trials is placed in the Basal Area Factor formula.

$$B.A.F. = \frac{43,560}{1 + 4\left(\frac{d}{w}\right)^2}$$

Where d is distance to target in feet, w is the width of target in feet.

A question that may arise is, how much can the measured distance from target to wedge be in error and still be within reasonable limits of giving a good answer?

(It should be noted that a given per cent error in the basal area factor will produce the same per cent error either in basal area calculations or in cruise volume calculations.)

The following table shows how much this distance (an average for six trials) may vary for a one and two per cent error in the basal area factor using various diopter wedges with a one-foot target.

DISTANCE ALLOWANCE IN CALIBRATING

Diopter	B.A. Factor within + -1% limits		B.A. Factor within + - 2% limits	
	* + - ft. for - 1%	Total Distance Allowance	* + - ft. for - 1%	Total Distance Allowance
4.0	.13 -	.25 +	.25 +	.50 +
5.0	.10 +	.20 +	.20 +	.40 +
6.0	.08 +	.17 -	.17 -	.34 -
8.0	.06 +	.12 +	.12 +	.25 -

*
+ feet allowance from exact distance from wedge to target center.
- feet allowance from exact distance from wedge to target center.

Example: An exact 4.0 diopter wedge is to be given a basal area factor. The range is set up and the previously described procedure followed. The true distance, by formula, from wedge to target is 25.00' when a one foot target is used. The average of, for example, six trials is 25.105' with a calculated basal area factor of 17.272. The correct factor of 17.417 varies 0.83% from the calculated factor of 17.272. Thus, any cruise made with the wedge marked as having a basal area factor of 17.272 will be 0.83% low when the volume calculations are made.

FIELD PROCEDURE USING THE WEDGE PRISM FOR BASAL AREA DETERMINATION

How to Establish the Sample Point

A series of sample points is established on the ground in the same manner as the center points of fixed-radius sample plots. Either full points (360 degrees) or half points (180 degrees) may be taken.

The half point is established as follows:

1. The point is established in the normal manner.
2. From the point, the compassman faces downhill regardless of the direction of the cruise line. (Whenever the crew consists of two or more men the compassman selects the half point to eliminate any bias that might be introduced if the cruiser established the point.)
3. He next picks a reference tree on his left that is on contour with the point. A stake may be set if a reference tree is not available. When it is desired that the point can be reestablished at a later date, the tree is blazed and marked with a 2.
4. The half point is established from the reference tree by extending an imaginary line across the plot center. All the trees on the downhill side of this line are potential "in" trees.

Normally a wedge of one diopter lower is used when half points are taken.

How to Determine Whether a Tree is "in" or "out"

From the sample point the surrounding trees are observed both through and over the wedge prism. The prism bends the rays of light passing through it by a fixed angle so that the transmitted image of the tree

is laterally displaced. If the edge of the direct and transmitted images overlap, the tree is considered "in" and it is counted. Figure C1 shows the diagram of an "in", "out", and "borderline" tree. Alternate "borderline" trees may be counted as being "in" or each "borderline" tree may be counted as a half tree. The distance between the eye and the prism does not affect the angular displacement of the prism. However, it is very important to keep the prism over the sample point. The cruiser sights on the tree at the point on the tree where his basic volume table diameters are indicated. Usually, that point is D.B.H. There are advantages to using a point higher on the tree; however, the basic volume table must then be adjusted to give diameters at that new point. The face of the prism should be at right angles to the line of sight and when this condition exists the lateral displacement of the image is minimum. The bottom edge should be horizontal on level ground. To correct for slope, the prism is rotated at exactly the same angle as the slope, but in a plane which is at right angles to the line of sight. Both the slope angle from eye to tree and the amount in which the wedge prism is rotated to correct for slope must be equal. An abney can be used to measure the amount of slope and then used to rotate the wedge to the same angle with the line of sight. Figure C2 shows the correct way to employ the abney and the wedge prism. Note that the line of sight is perpendicular to the face of the wedge prism.

The following are some pointers on determining whether a tree is "in" or "out":

1. For hidden trees the observation center may be moved away from the actual point as long as the distance from the point to the tree in question is maintained. By moving the observation center, it is often possible to get to one side of brush that is obstructing the view. It is necessary to move the center when a possible "in" tree is directly behind another tree.
2. For a leaning tree, rotate the wedge prism so that its vertical axis corresponds with the center of the stem of the tree.
3. Occasionally the displaced image of one tree will overlap an adjacent tree giving the appearance that it should be counted when actually it is "out". This can be avoided by careful observation of the trees involved to see whether the displaced image belongs to the tree that is overlapped. In some instances, having the compassman stand beside the closer tree will facilitate making the distinction.

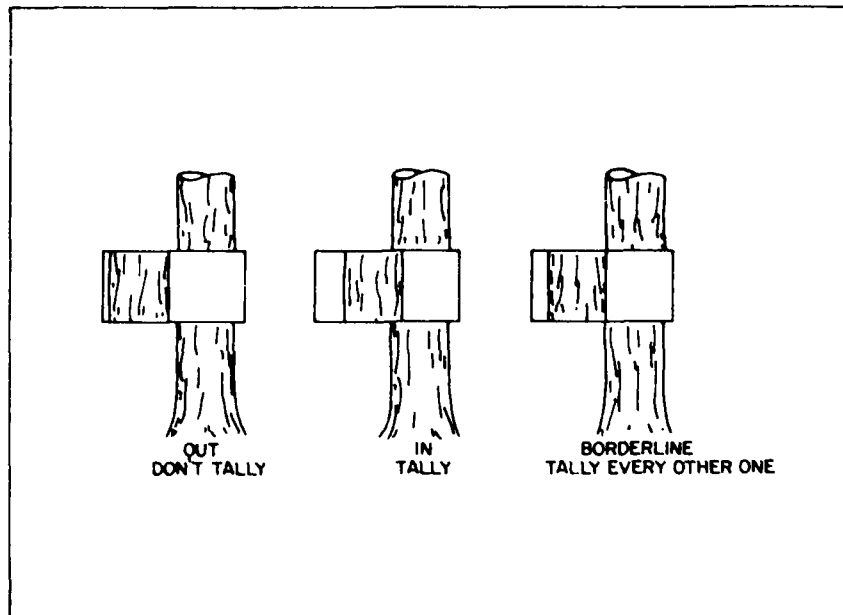


Figure C1. "In," "out," and "borderline" trees.

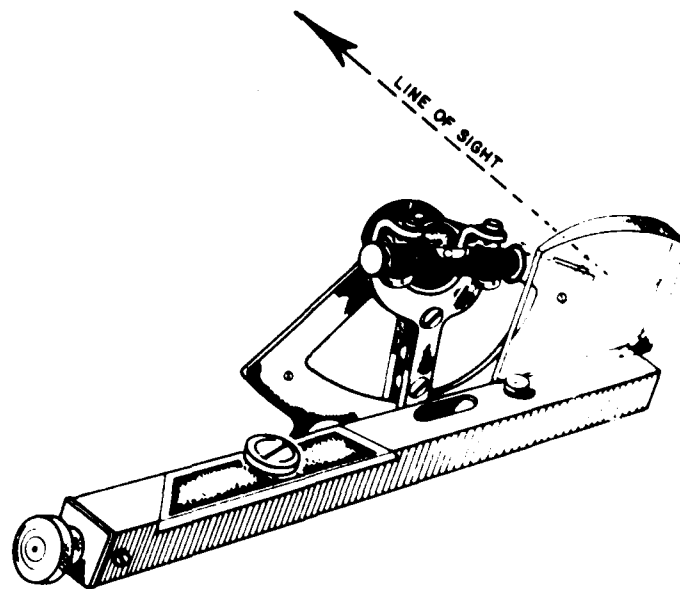


Figure C2. The correct way to employ the abney and the wedge prism.

4. In rare cases it may be necessary to remove some of the brush that is obstructing the view. The use of half points helps to eliminate the brush problem.
5. Normally the prism is held so that the image is displaced to the left. Reversing the prism so that the image is displaced to the right will aid in determining whether a tree is "in" or "out".
6. Another method of determining whether a tree is "in" or "out" is through the use of a plot radius factor. The distance from the point of observation to a tree that is just "in" is called the plot radius. The D.B.H. of any tree is directly proportionate to the plot radius. Thus, a plot radius factor can be computed for any wedge prism.* The D.B.H. in inches of any tree multiplied by the plot radius factor gives the plot radius in feet for a tree that is just "in". It is easily seen that there is a different plot radius for each different diameter. Thus, this method is often referred to as the variable plot radius method. The plot radius factor is particularly useful as a training aid.

How to Determine Basal Area per Acre

The average tree count per plot multiplied by the wedge prism factor gives basal area per acre.

Example: 21 points are taken which have a total tree count of 87. A wedge prism with a factor of 27.62 was used.

Average tree count = $\frac{87}{21} = 4.143$ (normally carried out to three decimal places)

$4.143 \times 27.62 = 114.4$ square feet of basal area per acre.

*The plot radius factor is computed from the following formula:

$$\sqrt{\frac{43,560 - B.A.F.}{4 B.A.F.}} \div 12 \text{ where B.A.F. = Basal Area Factor}$$

The plot radius factor may also be computed from the following formula (for any given wedge prism):

$$\frac{d}{12w} \text{ where } d = \text{distance to target in feet} \\ w = \text{width of target in feet}$$

APPENDIX D:

ALTERNATE SAMPLING METHODS

The following discussion presents alternatives to the methods described in Chapter 4 for sampling vegetation, mammals, and birds.

Vegetation

Equipment and Materials

1. Chaining Pins.
2. Tree Measurements: measuring stick, distance tapes, diameter tapes, compass, Biltmore sticks.
3. Sapling and Shrub Measurements: measured tapes.
4. Forage Production Measurements: clippers, paper bags, triple-beam balance, drying oven, long-handled pruner, calibrated sticks.

Choice of Area

General Location. The general location of a transverse line and its individual plots depends on the objectives of the data to be secured. In all instances the reasons for choosing the general location and the placement of the transverse line should be recorded.

The general location of each transverse line should be shown on a USGS map or copy (or equivalent on larger scale) so that this location can be approximated at a later date.

Specific Transverse Line and Plot Location. A specific starting point, compass direction(s), distance between plots, and number of plots for each transverse line must be established in advance of field work. All this information for each transverse line should be recorded. The first plot must be at least 50 yds (paces) (46 m) along the transverse line to avoid biased choice of plot locations.

The compass direction of the transverse line should be established for at least 25 yds (paces) (23 m) beyond the location of a plot so that the center of the plot can be established by measure (yards) or footfall (paces) rather than by some arbitrary decision. Finally, the center of each plot must be marked by a stake.

Vegetation Categories

1. Trees: over 4 in. (8 cm) diameter at breast height (dbh, 4 1/2 ft [1.4 m] above ground).
2. Saplings: 1 to 4 in. (3 to 8 cm) dbh.
3. Seedlings and herbaceous vegetation: under 1 in. (3 cm) dbh.

Tree Measurements. At each point, four trees are selected according to the point-quarter method (Curtis and Cottam, Plant Ecology Workbook, 1962, see Appendix A). Compass lines north-south and east-west are used as axes. The closest tree to the point in each quadrant is included in the sample.

The data to be recorded for each tree are:

1. Species.
2. Distance from the point to the center of the tree.
3. Dbh: use diameter tape.
4. Height to the top of the crown: use Biltmore stick. A Biltmore stick works by the principle of similar triangles. The investigator, standing at one chain (66 ft [20 m]) from the tree, holds the stick vertically at 15 in. (64 cm) from the eye. When the bottom of the stick is aligned with the base of the tree, other height measurements may be read. Avoid standing downhill from the tree when making height measurements (Figure D1).
5. Height to the bottom of the crown: use Biltmore stick.
6. Crown radius: three rays are projected from the center of the tree at 120 degrees from each other. A chaining pin is placed where a vertical line tangent to the crown intersects each ray. The average of the three pin-to-tree measurements is taken as the crown radius (Figure D2).

$$\text{Crown radius} = \frac{QA + OB + OC}{3} \quad [\text{Eq D1}]$$

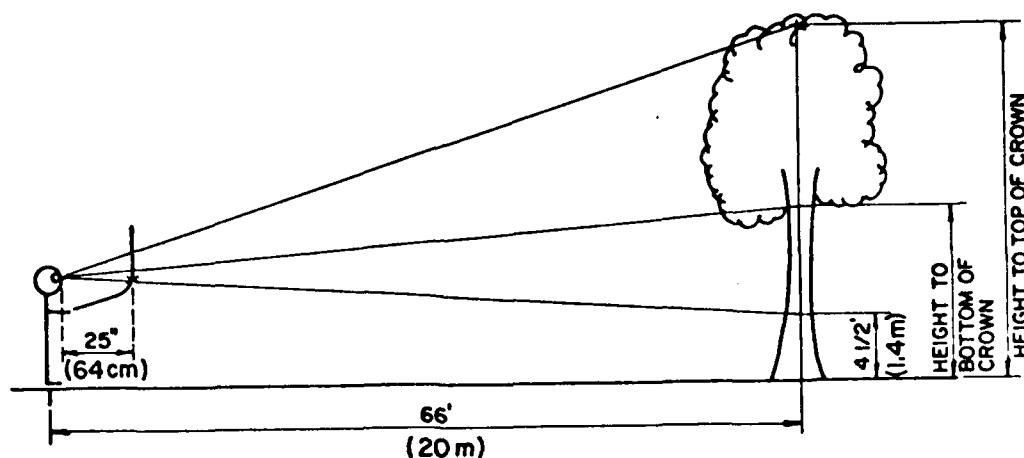


Figure D1. Use of the Biltmore stick for making tree height measurements.

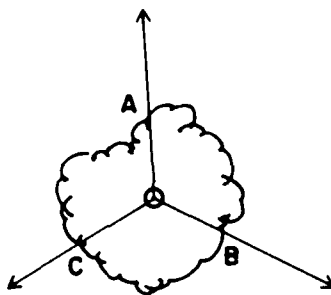


Figure D2. Determining crown radius for trees.

Note: Trees with multiple trunks are considered a single tree if the trunks are connected above ground. The dbh recorded (d_0) is calculated as the diameter of a single trunk having the same basal area as the sample tree (e.g., if the sample tree has two trunks with diameters d_1 and d_2 , $d_0 = \sqrt{d_1^2 + d_2^2}$).

Sapling Measurements. All saplings within 11.8 ft (3.6 m) from the point are included in the sample and tallied according to species (a radius of 11.8 [3.6 m] defines a 1/100 acre, with the same measurements taken as for trees).

Seedling and Herbaceous Vegetation Measurements. All seedlings and herbaceous vegetation within 3.7 ft (1 m) from the point (a 1/1000 acre plot) are included in the sample and tallied according to species.

A plot is established centered on the plot stake. All herbaceous and seedling vegetation is clipped at ground level from this 1-m-square plot, placed in a bag, and saved.

Calculations (Calculated by Species and Then Totaled If Identification Is Possible)

1. Trees.

a. Individuals per hectare = [Eq D2]

$$\frac{10\,000\text{ m}^2/\text{hectare}}{(\text{average distance trees [m]}^2)}$$

b. Basal area per hectare = [Eq D3]

$$\frac{10\,000\text{ m}^2/\text{hectare}}{(\text{average basal area per tree [m]}^2)}$$

2. Saplings.

a. Individuals per hectare = [Eq D4]

$$\text{average number of individuals per point} \times 100 \times 2.47$$

b. Basal area per hectare = [Eq D5]

$$\text{average basal area per point} \times 100 \times 2.47$$

3. Seedlings and Herbaceous Vegetation.

a. All clipped vegetation should be dried 48 hours at 55°C.

b. Biomass per hectare = [Eq D6]

$$\text{average dry weight per point} \times 1000 \times 2.47$$

Mammals

The following two methods of analysis can be implemented at the Stage II or III level, but supply less information than the capture-recapture method described in the main text; however, they are less complex, require less field time, and are less expensive. The final decisions on investments in manpower and finances, and on the level of accuracy desired will have to be made before using any of the guidelines in this report.

Capture-Removal Method

Equipment for this procedure is as follows:

1. Rat traps: 6 dozen
2. Mouse traps: 26 dozen
3. Oatmeal and peanut butter
4. Staked flags: 12 dozen.

The traps must be placed in a grid system enclosing 1 hectare (2.47 acres), with each set of traps 10 m apart (Figure D3). The traps are baited with a rolled oats and peanut butter mixture. The traps are set for five consecutive nights with the captured animals removed each morning and the traps rebaited. This method is generally more successful if the trap points are prebaited for 3 days prior to setting the traps. All captured individuals are identified; and sex, reproductive condition, and age (young or adult) are recorded. Trapping is done for only 5 nights, because animals outside the area will begin to move into the population vacuum created by the removal of resident individuals.

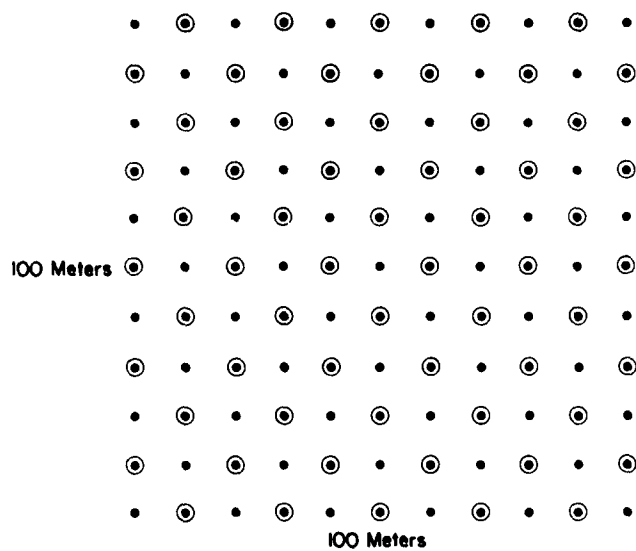
The population is determined by graphing the daily catch against the accumulated catch and drawing or calculating a regression line to determine the population (Figure D4).

Transect Method

Using the same equipment as for the capture-removal method, the traps are set in a straight line at a predetermined distance (every 3 or 4 steps, or other distance). The catch for this area is calculated as number caught per number of traps set times 100.

Birds.

The articles in Appendices E and F outline two alternative methods of censusing bird populations. These techniques are being investigated by CERL for further use by scientists and have not yet been thoroughly tested; but it would appear at this time that they will be found valid, because scientists are using them with reasonable success.



- = 3 mouse traps
- ⊙ = 2 mouse traps, one rat trap

Figure D3. Grid system for traps.

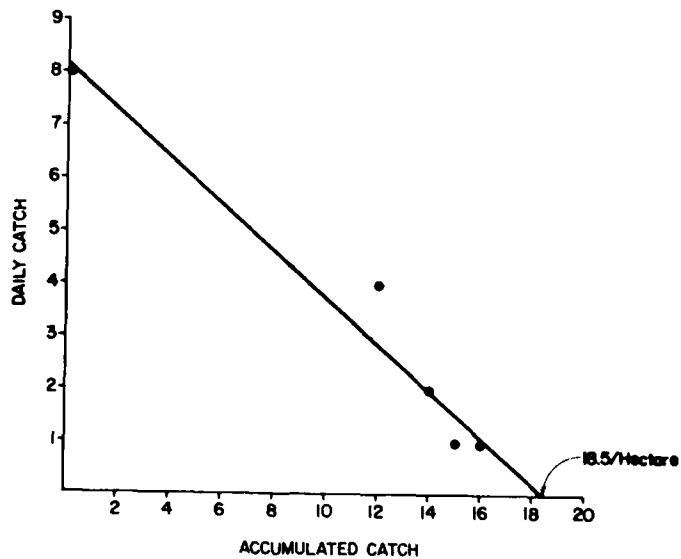


Figure D4. Mammal population.

APPENDIX E:

ANALYZING BIRD TRANSECT COUNTS

The following is a paper by Martha Hatch Balph, L. Charles Stoddart, and David F. Balph, "A Simple Technique for Analyzing Bird Transect Counts," The Auk, Vol 94, No. 3 (July 1977), pp 606-607.

A simple technique for analyzing bird transect counts.—Natural resource inventories commonly call for density estimates of all bird species in an area throughout the year. Transect methods (reviewed by Eberhardt 1968, J. Wildl. Mgmt. 32: 82 and by Emlen 1971, Auk 88: 323) are perhaps the most appropriate means for making such estimates. This paper describes a simple method of analyzing transect counts used by Balph and Balph (MS) to estimate bird densities by species at 2-month intervals through 1 year on a limited budget.

Data for analysis were collected on line transects in each of several vegetation types near an arid-lands river in eastern Utah. Information recorded included the identities of birds seen on transects and the lateral distance from the transect line to the point of first sighting. Lateral distances were grouped into the following meter intervals: 0–5, 6–10, 11–15, 16–20, 21–25, 26–30, 31–40, 41–50, 51–75, 76–100, and >100. The first interval (0–5 m) was judged to be wide enough to obtain a good sample, yet narrow enough to assume reasonably that all birds within the corridor would be seen. Variability was measured by comparing day-to-day counts made on the transects.

Data were used to maximize the density estimate for each species seen during a given transect walk. The procedure is illustrated using hypothetical data presented in Table 1. The largest number of individuals of species A (i.e. 7) occurs in the first (i.e. 0–5 m) interval. Given a transect 2,000 m in length, 7 individuals of species A are estimated to be present in a $5 \times 2,000$ m area doubled to include both sides of the transect—a corridor of 20,000 m². Expressed in number of birds per km², the density of species A is 350. For species B, the density estimate is maximized by averaging the values in the first two intervals, which gives 1.5 birds per

TABLE 1
HYPOTHETICAL DISTRIBUTION OF INDIVIDUALS OF SEVERAL BIRD SPECIES SEEN AT VARIOUS LATERAL DISTANCES FROM A TRANSECT LINE

Species	Distance from transect line (m)					
	0–5	6–10	11–15	16–20	21–25	26–30
A	7	5	2	2	0	1
B	1	2	0	1	0	0
C	0	0	0	0	1	0

20,000 m² or 75 per km². For species C, the estimated density is 0.2 birds per 20,000 m² or 10 per km². A generalized equation for this procedure is:

$$D = \frac{n}{l \times d \times 2} \times \frac{10^6 \text{m}^2}{\text{km}^2}$$

where D = density of birds (number per km²), n = number of birds observed between transect line and outside edge of last interval used in density estimate, l = length of transect in meters, d = number of meters from transect line to outside edge of last interval used in density estimate, and where the last interval used is that which gives the largest mean number of birds per meter of lateral distance.

This method of analyzing transect counts emphasizes the use of data obtained in the first interval from the transect line. Sightings outside of the first interval are of interest only when, due to small sample size, the number of individuals is largest in an interval other than the first. The logical and mathematical basis for this approach is given by Stoddart (Gross, Stoddart, and Wagner 1974, Wildl. Monogr. 40). No attempt is made to establish a species specific "sighting probability" (Eberhardt *ibid.*) or "coefficient of detectability" (Emlen *ibid.*), because few species occur with sufficient frequency to do so feasibly.

There may be some problems in treating the data in the manner described. The procedure assumes that the numbers of birds seen in the intervals used in the density estimate represent the actual numbers of birds present in those intervals. Since in most cases a progressively smaller proportion of the individuals present are likely to be seen at increasing distances from the transect line, the use of data from intervals other than the first to maximize the density of a particular species may result in an underestimated density figure for that species. However, we believe that the technique described is an adequate solution to the problem of making density estimates for all bird species encountered along a transect.

This paper is an outgrowth of work supported in part by the White River Oil Shale Project and ERDA contract no. E11-10-1329.—MARTHA HATCH BALPH, L. CHARLES STODDART, AND DAVID F. BALPH, Department of Wildlife Science, UMC 52, Utah State University, Logan, Utah 84322. Accepted 1 Dec. 76. (This paper was subsidized by the authors.)

APPENDIX F:

ESTIMATING BREEDING SEASON BIRD DENSITIES

The following is a paper by John T. Emlen, "Estimating Breeding Season Bird Densities From Transect Counts," The Auk, Vol 94, No. 3 (July 1977), pp 455-468.

ESTIMATING BREEDING SEASON BIRD DENSITIES FROM TRANSECT COUNTS

JOHN T. EMLEN

ABSTRACT.—In this paper I propose that for each species in an area the number of birds detected along a transect trail can be translated into an estimate of absolute density (birds per unit of area) by counting all the detectable (cue-producing) birds in a trailside strip narrow enough to permit detection of all cues produced (the specific census strip), and adjusting this count for the undetectable (silent) birds in the strip by applying a locally and concurrently derived index of the frequency of cue production for the species. Cue frequency is apparently impossible to measure in nonbreeding birds, but if all cues (sightings, calls, etc.) are used, most of the birds in the strip presumably will be detected when the observer advances slowly enough to allow each bird a good chance to make its presence known. In the nonbreeding season the strip width is set for each species at the distance from the trail at which total cue detection starts to decline. In the breeding season cue frequency may be determined for song cues, and strip widths for each species set at a convenient distance within the relatively great distance at which song detection starts to decline. Values obtained by these transect procedures reflect the density of each species at the time the traverse is run; a series of traverses may be made to provide mean values for selected periods through the season.

The method is similar to that described in an earlier paper. New or modified procedures are described for recording detections, establishing specific strip widths, bypassing the calculation of "coefficients of detectability," estimating distances in the field, determining an optimum rate of progress, and measuring the frequency of singing in a representative sample of the population.

Problems of converting adjusted transect counts of singing males to total population density and of applying a combination of all-cue and song-cue procedures to mixed populations of breeding and nonbreeding species are discussed.

A comparison of transect and plot map census methods is presented. In the transect method density estimates are of birds present at a particular time rather than of birds wholly or partially resident at one time or another during a season. The sampling quadrats of transect censuses are elongate rectangles spanning extensive tracts of habitat rather than truncated blocks of representative habitat. The transect method is applicable at any season while the plot map method can be used only during the breeding season when birds are singing on territories. Problems of reliability in the plot map method stemming from individual movements during a survey period and from questions on how to interpret clusters of observation points on territory maps and how to evaluate boundary line territories are replaced in the transect method by problems of accuracy in assuming complete coverage in the all-cue operations and in assigning birds as inside or outside the lateral boundary lines of the census strips. More area can be covered per unit of time in the transect than in the mapping method. —*Department of Zoology, The University of Wisconsin, Madison, Wisconsin 53706. Accepted 3 November 1975.*

THE PROBLEM AND THE MODEL

THE principal access to absolute density values (birds per unit of area) for land birds has been the spot-map method (Williams 1936, Robbins 1970). While reasonably satisfactory for many purposes, spot-mapping procedures are applicable only during the breeding season and on fairly small tracts. Success in estimating absolute densities in large areas has recently been achieved by coordinating absolute data from small mapped plots with relative data from extensive transect counts (Enemar and Sjostrand 1967, 1970), and in 1971 I described a method for translating counts of bird detections along a transect route to absolute density values by applying correction factors for each species based on the distribution of detection points laterally from the transect trail (Emlen 1971). Järvinen and Väisänen (1975) also used the principle of declining detectability with distance, applying three theoretical regres-

sion curves to the extensive narrow and broad belt census data of Merikallio (1946, 1958) and others on Finnish bird populations.

There is no test of accuracy for my 1971 distance attenuation method, but results appear to be reasonably satisfactory in the nonbreeding season when most birds close to the trailside provide sound or visual cues as the observer passes. It is quite unsatisfactory during the breeding season, however, when many individuals, notably nesting females, remain silent and essentially undetectable even at close range. This paper is concerned primarily with breeding season census problems but reviews various aspects of nonbreeding season transect procedures.

The relation between the number of cues tallied along a transect trail and the absolute density of birds that number represents appears to rest on two variables, both of which can be controlled or measured in many situations: (1) cue attenuation with lateral distance from the trail and (2) the frequency with which birds produce visual or auditory cues detectable by an observer at any range. This paper reexamines and revises the procedures for attenuation control described in my 1971 paper, outlines procedures for measuring cue frequency, and discusses methods for coordinating the two procedures in various situations. It also compares the characteristics, applicability, basic assumptions, advantages, and weaknesses of the transect and the traditional plot-map census methods. The appendix presents some results of preliminary field tests made in Wisconsin using the two methods.

Cue attenuation.—My basic procedure for controlling the attenuation of sound cues and visual cues with distance is to determine for each species the strip width along the trail within which a fully alert observer will detect essentially all cues that are produced. In my 1971 paper I projected the density within this strip to an outer boundary line and used the ratio of the actual count inside that boundary line to the projected total over many miles of transect as a coefficient of detectability for the species. The count within the strip can be used directly as a specific census strip, and this procedure has the advantage of being locality and period specific. In either case distances perpendicular to the trail on either side are estimated for each bird as it is detected, and tallied as dots or other symbols on survey sheets in columns representing narrow strips of terrain paralleling the trail. The symbols in these columns are totaled for each species at the end of a survey or series of surveys, and the accumulated data are plotted as a regression curve with the transect trail serving as the base. Curves typically show fairly level basal plateaus out to from 30 to 200 feet (9–60 m), depending on the species, before declining rapidly or gradually to zero at the limits of detection.

On the assumption that (1) I miss relatively few cues in the proximal strips immediately adjacent to the trail, and (2) the plateau form of the curve indicates that there is no appreciable additional loss in detection out to the inflection point of the curve, I adopt the inflection point or some convenient point within it on either side of the trail as marking the lateral boundaries of the specific census strip for the species. These lateral boundary lines and the ends of the transect route define the areal base for the density function as well as delimiting the area in which cues can be accepted for density determinations. Specific census strips are thus elongate quadrats within which cue detection approaches completeness. They must not be confused with the areas used in the flushing distance method of King (Leopold 1933, Hayne 1949) in which the estimated distances are along radii emanating forward and laterally from the advancing observer.

In addition to applying the specific census strip directly in place of the derived

coefficient of detectability I have made several innovations or modifications of procedure since presenting the transect census model in 1971: (1) To meet the problem of obtaining adequate samples for an uncommon species I may arbitrarily group the available data with those for one or more common species displaying similar cue-attenuation characteristics to derive an approximate value.

(2) Where habitats occur in narrow linear shapes as along a riverbank, a roadway, or an urban city block, I adopt the natural boundary of the habitat to define the census strip except for species in which the specific strip is narrower than the habitat strip.

(3) Where birds are concentrated in flocks it is often difficult to tally each individual as a separate dot on the survey sheet. Under these conditions I estimate the flock size and treat it as a unit, apportioning the lateral distribution points according to my best estimate of the position and dispersion of the flock at the moment it was encountered.

(4) Where, as in the breeding season, the detectability of members of a population fluctuates rapidly and irregularly or varies strongly among individuals, I focus on one or a few of the most stable cue types, such as song, and base my specific strip boundaries and calculations of density exclusively on these. Data obtained by this procedure require special adjustments for cue frequency as described below.

Cue frequency.—Cue attenuation should theoretically be completely controlled by the procedures described in the previous section, the observer simply basing his density calculations for each species on the count obtained in the relatively narrow strip within which his tally of detectable cues approaches completeness. But, entirely aside from cue attenuation, individual birds may still be bypassed because they produce no detectable cues, either visible or audible, while the observer is within detection range. These momentarily undetectable birds cannot be counted directly, but their numbers can be computed if the frequency of cue production (the proportion of observer encounters in which the birds make their presence known by emitting detectable cues) is determined for a representative sample of the strip's population and interpreted as the proportion of detected individuals in the total population of the strip. Thus, in a hypothetical case, if 10 birds of a selected species are detected on a transect count run at a speed that gives the observer 6 min within the detection range of each bird, and it is independently determined that representative members of the population make themselves detectable in 50% of a series of 6 min test periods in which they are continuously within detection range, we can conclude that 10 additional birds were bypassed on the transect count and that the population in the strip is 10 detected plus 10 undetected birds = 20 birds.

The frequency of cue production is difficult to determine under most conditions because when an observer follows them persistently, birds tend to alter their natural behavior in ways that make them less or more detectable. *Total* cue frequencies (using all visual and sound cues) are, in fact, essentially unattainable, but fortunately during much of the nonbreeding season most of the birds within the narrow specific strip seem to make their presence known if the observer advances slowly and restricts his counts to favorable early morning conditions (Emlen 1971).

Cue frequencies can apparently be estimated with reasonable accuracy during the breeding season if calculations are based exclusively on song. Representative territorial males may be selected as samples and watched continuously over extended periods (Enemar 1959). Or, as it is difficult to recognize truly representative birds, a

series of territorial males may be visited repeatedly for shorter periods and their individual song frequencies averaged (Hickey 1943).

When cue frequencies are based exclusively on song cues, transect counts must, of course, also be restricted to songs. The tally will thus be smaller, but the much wider specific census strips that can be employed when only loud vocalizations are used in determining attenuation distances, and the longer bird-observer exposure times available for each territorial singer compensate for the omission of numerous nonsong cues from the calculations.

Density computation —When cue frequency cannot be measured, as when all cues are used during the nonbreeding season, density must be computed entirely from cue attenuation data. When indices on cue frequency are available, as for song in the breeding season, total density can be computed by multiplying the count of detected (cue-producing) birds in the census strip by the reciprocal of the locally determined cue frequency for the species.

The density values obtained by the specific strip census method, with or without application of cue-frequency data, apply to the population present in the strip at the time the traverse is run. Individual birds that drift back and forth across the boundary lines are included if they happen to be inside, excluded if they are outside when the observer passes. The effects of such transboundary movements will presumably balance out for common species on long traverses, and fluctuations in a stable population should be small in a series of standardized traverses over the same route. Variations in computed density will occur, however, with changes in weather and variations in field procedure such as rate of progress or time of day.

When procedures are standardized, density estimates for a series of specific strip traverses may be averaged to reduce errors caused by small sample sizes, or statistically analysed for information on the completeness of cue detection under various conditions. Palmgren (1930) discussed the averaging of transect-derived density values for an area, noting that in open (no strip boundary) transects or where wide fixed strips are used, the largest count for a species in a series of traverses will approach the actual population level more closely (be more complete) than the mean for the series. This principle applies in situations where the population being counted is assumed to be definitive and where variations in the count are due to variations in the completeness or efficiency of the counting; it does not apply to specific strip counts where the population being counted fluctuates as birds drift back and forth across the boundary line and where all counts are assumed to be essentially complete or at least representative of the birds present within the indicated boundaries when the count was made.

FIELD PROCEDURES FOR THE NONBREEDING SEASON

To estimate densities of nonsinging, nonterritorial populations along a transect route one should use all available cues and follow the procedures described above under cue attenuation. The values will theoretically be complete for all cue-producing (detectable) birds in the specific census strips. Silent and inactive (undetectable) birds will inevitably be bypassed, and no satisfactory technique has yet been devised for estimating them. In the absence of data on cue frequency, best guess adjustments (basal detectability adjustments) may be made for these undetected birds where best estimates are preferable to minimum estimates.

FIELD PROCEDURES FOR BREEDING SEASON POPULATIONS

To estimate breeding season densities by the specific strip method one should use only song cues and then adjust the tallies of singing males for the unrecorded non-singing males and females. This procedure calls for two separate operations in the field, (1) tallying all song detections and their lateral distances along the route, (2) determining indices of song frequency during the census period. Although these two operations are functionally distinct, the data for each may be collected concurrently along a transect route without prejudice to either set of data and without loss of time.

Counting singing males.—The field procedures for song transects are similar to those used in all-cue transects as described in my 1971 paper, but involve a number of special considerations as discussed below:

(1) *Record all detections.*—Although density calculations in this model are based entirely on song cues, all detected cues should be recorded. Song cues should be clearly differentiated from the others on the tally sheet by some distinctive symbol such as a small circle or the letter s.

(2) *Song strip boundaries.*—Because songs in most species can be heard at relatively great distances, the basal plateaus of lateral regression curves are much broader when based exclusively on song cues than when soft call notes and sightings are also included. Under these circumstances the problems of distance estimation and density calculation can be simplified by setting the boundary lines for the census strip at some convenient arbitrary distance well inside the limits of song detection set by sound attenuation. In the Wisconsin test study (see Appendix) I selected 200 feet on either side of the trail (a 400-foot strip) for most species and 100 feet (200-foot strip) for a few quiet-voiced species.

(3) *Distance estimates.*—As distances from the transect trail to unseen singing birds can rarely be measured, a subjective approach is necessary. Elaborate estimation techniques must be avoided, however, as they involve distractions that can affect the efficiency of distant song detection adversely (Merikallio 1946). Fortunately if a fixed distance well within the absolute limit of detection is set, as advocated in the preceding paragraph, the only critical decision to be made for each observation is relatively simple, whether or not the bird is inside or beyond that prescribed census strip boundary line when first detected. In most cases the correct answer is subjectively obvious, but there may be a good many borderline cases. In any event, every census-taker must face the subjectivity problem squarely and work out a system for himself in which he can test his performance level objectively at frequent intervals. I find that with practice I can almost invariably predict to within 10 or 15% the number of paces (3 feet) it will take me to reach a selected fixed object 200 feet away, the distance to the strip boundary line for most species in breeding season transects. This level of accuracy I am obliged to accept as the best I can do. In making these estimates for self-testing and in actual transect count situations, I find it helpful to cultivate and retain mental images of familiar settings with known dimensions, such as a room in my home, a tennis court base line, a fallen 100-foot tree, or a 100-yard race track straightaway.

To apply these acquired skills to an unseen songbird along a transect route one must first determine the approximate location of the source of the sound with reference to some conspicuous and fixed object in the habitat such as a distinctive tree trunk or a tall shrub, and then estimate the distance of that object from the trail when he is approximately opposite it. Both the locating and the estimating operations

TABLE 1
SOME COMPARISONS OF THE PLOT-MAP AND TRANSECT-STRIP CENSUS METHODS

Plot-map method	Transect-strip method
<i>Objectives</i> To estimate the number of birds resident during the breeding season.	To estimate the number of birds present during a single census operation.
<i>Nature of the data</i> Data units are the territories lying within or partially within (fractions) the plot boundaries. Each visit to the plot contributes data to a single census estimate for the season. Plots are usually truncated in shape.	Data units are the individual detections of birds as the observer moves along the route. Each traverse of the route provides the complete record for a definitive estimate; the results of repeated traverses can be averaged. Plots are elongate in shape (strips).
<i>Applicability</i> Limited to the season when birds are on territories. Plots must be replicated when objective is to characterize a region or vegetation type.	Applicable at any season. A long transect plot provides a representative sampling of a region or vegetation type.
<i>Problems of procedure and interpretation</i> (Repeated traverses over the same area will reduce errors of omission.) (No distance estimates are required.) Double recording of individuals is difficult to control unless neighboring males sing concurrently. Determination of territory boundaries on base maps may be difficult especially where territories are contiguous. Determination of the fraction of boundary line territories lying within a plot requires knowledge of the transboundary extensions. Individual territorial birds may enter, leave or shift within a plot between spaced visits.	In the absence of cue frequency data (non-breeding season) an unknown number of silent (no cue) birds within detection range (the specific strip) will be bypassed in the single traverse that constitutes a definitive transect census. Lateral distance measurements to detection points are only rough subjective estimates. (Double recording is rarely a problem when following a straight transect course at more than 0.70 mph.) (Precise boundary determinations are not required.) (No territory evaluations are required.) (Intervisit changes are minimal when intervals are short.)
<i>Efficiency (hypothetical) in hours</i> For a 24-acre plot (birds resident through the breeding season) Staking and mapping — 10 hr. Vegetation survey — 4 hr. 8 surveys × 2 hr — 16 hr Total — 30 hr	For a 24-acre (0.5 mi × 400 feet) strip segment (birds present during three 5-day periods) Mapping — 2 hr. Vegetation survey — 4 hr. 15 traverses × 0.6 hr. — 9 hr. Total — 15 hr.

are best accomplished by moving along the trail and sighting towards the object or the sound source from several spaced points. A clearly visible and reasonably straight trail is important as a reference base for this operation. Major landmarks previously plotted to scale on a strip map of the route (see next subsection) greatly facilitate all distance estimates in the tract.

(4) *Rate of advance* — The rate of progress along the trail and the distance ahead and to the rear within which songs should be recorded are critical insofar as they determine the length of time the observer is exposed to each bird on the census strip. A net walking speed of about 0.75 mph combined with a 200-foot limit for recording birds, fore and aft, allows 6 min for each bird. Where 200 feet is also used as the lateral distance to the strip boundary (see consideration 2 above), the observer is, in effect, concentrating his attention on the birds in a slowly advancing 400-foot square area in which he is centered.

TABLE 2
CENSUS DATA FOR A 48 ACRE STAND OF MIXED WOODLAND IN WISCONSIN¹

	Total count per mile ²	Width of specific strip ³	Total count in specific strip ⁴	Song count in 200-foot strip ⁵	Song frequency ⁶	Territories in 200 foot strip ⁷
Mourning Dove (<i>Zenaidura macroura</i>)	2.0	40 + 40	0.5	0.64	0.40	2.0
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	0.1	200 + 200	0.28	0.09	v ⁸	—
Common Flicker (<i>Colaptes auratus</i>)	1.9	60 + 60	0.9	0.45	0.15	3.1
Red-bellied Woodpecker (<i>Melanerpes carolinus</i>)	0.4	100 + 100	0.2	—	—	0.5
Downy Woodpecker (<i>Picoides pubescens</i>)	2.2	100 + 100	1.3	—	—	4.0
Great Crested Flycatcher (<i>Myiarchus cinerascens</i>)	0.6	200 + 200	0.2	—	—	0.4
Blue Jay (<i>Cyanocitta cristata</i>)	13.0	100 + 100	8.4	—	—	8.2
Black-capped Chickadee (<i>Parus atricapillus</i>)	16.2	60 + 60	10.4	—	—	8.8
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	0.2	200 + 200	0.1	—	—	0.2
Red-breasted Nuthatch (<i>S. canadensis</i>)	1.1	100 + 100	0.9	—	—	1.0
House Wren (<i>Troglodytes aedon</i>)	3.1	200 + 200	3.88	1.91	0.66	3.0
Gray Catbird (<i>Dumetella carolinensis</i>)	5.2	40 + 40	1.6	1.68	0.44	7.9
Brown Thrasher (<i>Toxostoma rufum</i>)	4.3	60 + 60	2.9	0.91	0.19	6.0
American Robin (<i>Turdus migratorius</i>)	6.3	40 + 40	3.3	0.91	0.13	8.1
Wood Thrush (<i>Hylocichla mustelina</i>)	3.0	200 + 200	3.58	1.77	0.52	3.6
Cedar Waxwing (<i>Bombycilla cedrorum</i>)	0.6	50 + 50	0.6	—	—	1.0
European Starling (<i>Sturnus vulgaris</i>)	0.3	100 + 100	0.2	—	v	—
Common Yellowthroat (<i>Geothlypis trichas</i>)	0.6	200 + 200	0.68	0.32	0.27	1.0
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	0.4	200 + 200	0.58	0.23	0.60	—
Northern Oriole (<i>Icterus galbula</i>)	0.3	100 + 100	0.3	0.09	0.10	0.8
Common Grackle (<i>Quiscalus quiscula</i>)	7.7	40 + 40	4.2	—	v	—
Brown-headed Cowbird (<i>Molothrus ater</i>)	4.7	50 + 50	2.2	1.95	0.51	3.5
Cardinal (<i>Cardinalis cardinalis</i>)	6.4	60 + 60	3.0	2.91	0.59	7.0
Rose-breasted Grosbeak (<i>Phœniceus ludovicianus</i>)	2.4	50 + 50	0.8	0.86	0.28	4.2
Indigo Bunting (<i>Passerina cyanea</i>)	0.8	200 + 200	0.88	0.41	0.53	0.9

¹ Twenty traverses along a 1.10 mile transect route through a 48 acre stand in Madison, 18 June to 7 July 1974.

² All birds detected by sightings, calls or songs, per mile.

³ Distance between inflection points for the species on each side of trail, in feet.

⁴ All birds detected by sightings, calls or songs within the specific strip, or songs detected (indicated by S or 2, whichever is larger).

⁵ All males detected by song within 200 feet (100 feet for catbirds) per mile.

⁶ Proportion of 8 min. territory crossings in which the resident bird sang.

⁷ Sum of whole or fractional territories as determined by clusters of points representing song sites within 200 feet of trail on date when the species population was at maximum.

⁸ v = nonresident vagrants.

TABLE 2—Continued

	Total count per mile ²	Width of specific strip ³	Total count in specific strip ⁴	Song count in 200-foot strip ⁵	Song frequency ⁶	Terri- tories in 200-foot strip ⁷
American Goldfinch (<i>Spinus tristis</i>)	1.0	50 + 50	0.5	0.18	0.25	0.9
Rufous-sided Towhee (<i>Pipilo erythrophthalmus</i>)	3.1	50 + 50	1.0	1.73	0.72	0.8
Field Sparrow (<i>Spizella pusilla</i>)	2.6	200 + 200	2.7	1.36	0.60	2.8
Song Sparrow (<i>Melospiza melodia</i>)	0.4	200 + 200	0.4s	0.14	0.75	0.3

(5) *Number of traverses.*—Because the calculated values obtained in these transect censuses apply to the number of birds in the strip at the moment of counting, traverses over a route may be repeated and averaged. To avoid complications related to seasonal or breeding cycle changes, such traverse replications should be made within a limited period, ideally on successive days. For reasons explained in the next subsection, the number of replications in a series is limited to about 5 when song frequency measurements are involved. Double (10) or triple (15) series may, of course, be used. Where a composite record for an entire breeding season is desired, as in traditional spot-mapping censuses, several series of counts will be needed, perhaps one 5-day series every 2 weeks.

Determining song frequencies.—The conversion of transect counts of singing males to population densities requires measures of mean song frequency for the area and season in which the counts were made. A series of observation periods at territories located along the census route can provide a record of the mean incidence of singing by their resident occupants. This operation can be coordinated with the transect count operation to provide song incidence records efficiently for the same population and periods as those covered by the count.

A simple strip map of the route (scale about 1:2400) showing prominent landmarks to 200 feet laterally should be prepared at the start. I carry a set of such strip maps, one for each resident species, on my clipboard beneath the census tally sheet for the day. On these maps I plot the position of each detection point as a colored symbol and draw lines to indicate a bird's movements from perch to perch. I use a different color on the maps for each traverse, and as I can clearly discriminate only five colors of small dots on a map, I set five as the number of traverses in a series. Each map thus provides the complete record for a species over a series of 5 traverses. Obvious clusters of differently colored symbols and lines delineate the territories of localized males on these maps, and song frequencies can be read directly as the number of color-distinct song symbols in a cluster (from 0 to 5) divided by the number of visits or checks of the territory in a series—always five. In this system a species with six recognizable territories along a strip provides a sample size of $6 \times 5 = 30$ song checks. Mean frequency values obtained in this way will be too high if the count of territories is incomplete because of the presence of nonsinging males (zero frequency) that fail to reveal themselves by any cue during the five visits to their territory, or that are detected by nonsong cues only once or twice and classed as nonterritorial birds.

The additional time needed for the double entry of detections in this coordinated transect-song check procedure is negligible, and the attention needed for carefully

TABLE 3
THREE DENSITY ESTIMATES (BIRDS PER 100 ACRES) BASED ON THE CENSUS DATA PRESENTED IN
TABLE 2¹

	Transect method		Plot-map method ⁴
	Based on all detected cues ²	Based on song cues and adjusted for song frequency ³	
Mourning Dove	4.8	6.6	7.5
Yellow-billed Cuckoo	0.4	v	v
Common Flicker	6.0	12.4	11.7
Red-bellied Woodpecker	0.9	—	1.9
Downy Woodpecker	5.2	—	15.0
Great Crested Flycatcher	0.4	—	1.5
Blue Jay	17.2 ⁵	—	30.1
Black-capped Chickadee	25.1 ⁶	—	33.1
White-breasted Nuthatch	0.2	—	0.8
Red-breasted Nuthatch	3.4	—	3.8
House Wren	7.8	11.9	11.7
Gray Catbird	15.7	31.4	29.7
Brown Thrasher	20.1	19.7	22.8
American Robin	32.2	28.8	30.8
Wood Thrush	7.4	14.0	13.7
Cedar Waxwing	4.9	—	4.1
European Starling	0.9	v	v
Common Yellowthroat	1.3	4.9	3.8
Red-winged Blackbird	1.0	1.6	1.3
Northern Oriole	1.1	3.7	3.4
Common Grackle	41.0	v	v
Brown-headed Cowbird	18.4	15.7 ⁷	20.7 ⁷
Cardinal	21.0	20.3	26.3
Rose-breasted Grosbeak	6.4	12.6	15.8
Indigo Bunting	1.7	3.2	3.4
American Goldfinch	3.7	3.0	3.8
Rufous-sided Towhee	7.5	6.0 ⁸	4.9 ⁸
Field Sparrow	5.7	9.4	10.5
Song Sparrow	0.7	0.8	1.1

¹ No values are given in column 2 for nonsinging species and in columns 2 and 3 for species that were represented only by vagrants (v).

² Calculated for 100 acres from column 3 in Table 2.

³ Calculated from column 4 in Table 2 and adjusted for song frequency (column 5) and for undetected females.

⁴ Calculated from column 6 in Table 2 and adjusted for undetected females.

⁵ Fledged juveniles (est. 2 per average family flock of 4) have been subtracted.

⁶ Fledged juveniles (est. 4 per average family flock of 6) have been subtracted.

⁷ Observed sex ratios of cowbirds suggest an average of about two females per male. Male territories were very large and difficult to plot.

⁸ Only one of the two singing males on the tract was paired.

placing the symbol on the map is complementary to, rather than competitive with that needed for assigning a lateral distance value on the tally sheet.

Conversion to absolute density estimates.—The adjustment or conversion factor for a count of singing males in a song-cue transect strip is the reciprocal of the song incidence for that population and period. This holds for both high and low song frequencies, a low frequency simply indicating the need for a large adjustment. The method is thus applicable over wide ranges of singing activity.

Densities computed for a song-cue strip should be converted to standard units such as birds per 100 acres or square kilometers. Where the strip width for a species has been set as 200 feet on either side of the trail, one mile of strip will cover 48.5 acres. Conversion to birds per 100 acres in this case is accomplished by multiplying the density in the strip by $100/48.5 = 2.06$.

To obtain total population density for a species, the value obtained for male density must be adjusted for the uncounted females. For monogamous singing species in the Wisconsin test area I applied the imprecise but not unreasonable assumptions that the song tallies reflected both resident and vagrant males, and that

TABLE 4
SINGING INCIDENCE OF TERRITORIAL MALES AT MADISON, WISCONSIN, DURING FIVE PERIODS BETWEEN 18 JUNE AND 17 AUGUST 1974.¹

	18-29 June		1-7 July		14-19 July		21 July-5 August		12-17 August	
	Inc.	N	Inc.	N	Inc.	N	Inc.	N	Inc.	N
Mourning Dove	0.37	(30)	0.43	(40)	0.43	(30)	0.27	(30)	0.33	(30)
Common Flicker	0.30	(30)	0.15	(40)	0.18	(40)	+	X	+	X
House Wren	0.70	(50)	0.64	(80)	0.50	(60)	0.60	(20)	—	X
Gray Catbird	0.50	(100)	0.38	(90)	0.31	(110)	—	(90)	—	(120)
Brown Thrasher	0.18	(80)	0.20	(60)	0.03	(80)	—	(60)	—	(70)
American Robin	0.06	(80)	0.19	(90)	0.23	(90)	0.40	(10)	—	X
Wood Thrush	0.58	(80)	0.43	(60)	0.43	(80)	0.23	(60)	0.03	(30)
Common Yellowthroat	0.35	(20)	0.20	(20)	0.40	(20)	0.20	(10)	—	X
Brown-headed Cowbird	0.60	(50)	0.37	(30)	—	X	—	X	—	X
Cardinal	0.64	(80)	0.54	(80)	0.41	(80)	0.35	(60)	0.40	(50)
Rose-breasted Grosbeak	0.45	(40)	0.10	(50)	0.04	(50)	—	X	—	X
Indigo Bunting	0.65	(20)	0.35	(20)	0.30	(10)	—	X	—	X
American Goldfinch	0.10	(20)	0.15	(20)	0.35	(20)	0.13	(30)	0.10	(30)
Rufous-sided Towhee	0.80	(20)	0.65	(20)	0.80	(20)	0.70	(10)	0.50	(20)
Field Sparrow	0.70	(30)	0.50	(30)	0.37	(30)	0.55	(20)	0.35	(20)
Song Sparrow	0.80	(10)	0.70	(10)	0.20	(10)	0.10	(10)	—	X

¹ Values are the proportions of 4-6-min. early morning visits to (crossings through) territories during which the resident bird sang. Numbers in parentheses give the sample size for each value (territories \times visits).

the overall sex ratio in the populations was roughly equal. On this basis I simply multiplied the computed male density by two.

Procedures for nonsinging species.—A number of species in a breeding community such as the woodpeckers and jays may have nothing equivalent to the loud and frequent advertisement songs of most song birds, yet remain localized as pairs or small flocks for at least part of the breeding season. Such species can be treated as nonterritorial birds by recording all cues and assuming nearly complete cue frequency within the specific census strip of the species (the nonbreeding season procedure) or, when these birds are foraging in flocks or pairs on delimited home ranges, they can be sampled for total cue frequency in the same manner that singing species are sampled for song frequency. The frequency value can then be applied to the tally of pairs or flocks within the census strip of the species to provide a density estimate for pair or flock units. Adjustment of this estimate to total adult density for the species may then be accomplished by multiplying the number of flocks by an independently derived value of mean flock size. This procedure alleviates the practical problem of counting the individuals in each flock when encountered in the field.

FIELD PROCEDURES FOR MIXED AND TRANSITION POPULATIONS

The seasonal transition from breeding to nonbreeding condition and back is gradual in populations of any given species, and an avian community characteristically contains both breeding and nonbreeding species through much of the year. Thus a census taker will often be confronted with a mixture of species, some needing the all-cue method without frequency adjustments and others eligible for the song-cue method incorporating measurements of song frequency. The choice will generally be determined by the uniformity and frequency of cue production by the birds at the time, and the opportunities available for recognizing and keeping tabs on individual birds as required by cue-frequency measurement procedures. With field operations standardized and restricted to optimum weather conditions, reasonably high uniformity and frequency of cue production can be assumed for most species through much of the nonbreeding season and, for some, throughout the year. Opportunities for

individual recognition are provided when individuals isolate themselves on distinct and exclusive territories where they can be visited and checked periodically, and this occurs for many species in the breeding season and for a few throughout the year.

As communities often contain representatives of both categories simultaneously and as a species may change from one category to the other rather rapidly, field procedures should be designed to cover the data requirements for each. This raises no serious problems, and a tally sheet can be planned that provides space for recording all the pertinent information for each procedure. Strip maps are, of course, required for song-frequency measurements and should be included with the tally sheet whenever the use of this procedure for one or more species seems indicated. The choice between simple cue attenuation (all cues) and song-frequency procedures can then be made after the fieldwork is completed with full data in hand. Where density values are obtained for a species by both methods simultaneously, a selection between the two can be made on the basis of size and clarity of the data samples supporting each and on considerations of the basic reliability of the two procedures (see Appendix).

DISCUSSION

The transect method differs from the familiar territory mapping method (see Robins 1970) in the nature of the density values obtained, in aspects of reliability and accuracy, and in overall efficiency. The summary and comparison of the two methods presented in Table 1 may be useful in selecting the best approach for various types of ecological and behavioral studies. Some of the major considerations are discussed in greater detail below.

Density values.—Transect censuses provide data on the number of birds of each species on a transect plot (strip) at the time the traverse is made. Repeated traverses along the same route within the span of a week or two provide replicate samples of the same population suitable for averaging and other statistical treatments. By contrast, the territory mapping method provides a composite record of the number of individuals of each species resident on the selected plot at one time or another during a breeding season. Repeated visits to the plot increase the completeness of the record but do not constitute replications and cannot be averaged. In the transect method time-bracketed series may be repeated on the same plot at spaced intervals to provide data for an overall record for the season, while in the territory mapping method, provided adequate data are collected, the record may be broken down by periods to provide information on direct species associations or on changes in community structure and distribution as the season advances.

Where the objective of a census operation is to determine mean density values over a large area or an extensive habitat type, a long rectangular strip transecting the area, as provided by the transect method, will produce a better sampling than a compact, truncated plot (of the same size). Where the objective is to measure the populations on a small island or an isolated block of distinctive habitat too small to accommodate an elongate transect strip, the mapping method is preferable.

Where a record of seasonal changes through a full year is desired the territory mapping method is inapplicable. The specific-strip transect method as described in this report may be applied, although the necessary changes of procedure between the breeding and nonbreeding seasons may give rise to errors.

Reliability and accuracy.—Territories that overlap census plot boundary lines present problems for evaluating densities by the territory mapping method. This

problem assumes major proportions when species' territories are large in relation to the census plot. Unless information is obtained on the boundaries of such territories outside the plot, the fraction inside, and hence the number of birds represented, cannot be reliably evaluated. The problem of boundary line territories is bypassed in the transect strip method as the census units are simply birds present inside the strip at the moment of counting. For song frequency determinations in the breeding season the samples can be restricted to resident birds whose territories lie across or near the trail and who can thus be assumed to remain continuously within hearing range.

A second source of error in the territory mapping method is in the interpretation of clusters of observation points as territories. This becomes particularly difficult where a species is abundant and territories are contiguous. Supplementary notations of concurrent singing by neighboring territory holders and of behavioral interactions between such neighbors are very useful in locating boundary lines in these cases, but interpretations of the same set of data by several experienced observers may still differ considerably (Svensson 1974, Best 1975, Mannes and Alpers 1975). Transect counts do not require any interpretation of territory boundaries, and the samples for song-frequency measurements may be selected judiciously to avoid territories in confusing situations.

While the transect method escapes the hazards of misinterpreting boundary line overlaps and point clusters on census maps, a fair comparison of the two systems must balance threats to reliability against the threats to accuracy posed by the investigator's inability to verify the two basic assumptions of the variable-strip transect method, completeness of count close to the trail, and even distribution laterally from the trail. Theoretically the former can be covered by adjustments for cue frequency during the breeding season, but remains a serious factor of unknown and variable magnitude at other times; the latter must be controlled as far as possible by selecting census tracts with broad stretches of essentially uniform habitat structure.

Efficiency.—The relative efficiency of the two methods in terms of time and effort is difficult to judge because a single composite density value for a season cannot be equated readily with a series of time-bracketed values distributed through the same season. Using hypothetical values, however, I estimate in Table 1 that to obtain a single composite density value by the mapping method requires roughly twice as many hours as a series of three time-bracketed mean density values based on five transects each. This apparently greater efficiency of the transect method must, of course, be weighed against considerations of the nature of the values desired for any particular study.

ACKNOWLEDGMENTS

Much of the fieldwork underlying the development of this method was done with support from grants from the National Science Foundation and The Frank M. Chapman Memorial Fund. In preparing this report I benefitted much from critical comments and suggestions by Joseph J. Hickey, Margaret B. Hickey, Olli Järvinen, and Chandler S. Robbins. This paper is publication No. 79 of the University of Wisconsin Arboretum.

LITERATURE CITED

- BEST, L. B. 1975. Interpretational errors in the "mapping method" as a census technique. *Auk* 92: 452-460.
EMLEN, J. T. 1971. Population densities of birds derived from transect counts. *Auk* 88: 323-342.
ENEMAR, A. 1959. On the determination of the size and composition of a passerine bird population during the breeding season. *Vår Fågelvärld*, Suppl. 2: 1-114.

- , AND B. SJOSTRAND. 1967. The strip survey as a complement to study area investigations in bird census work. *Vår Fågelvärld* 26: 111-130.
- . 1970. Bird species densities derived from study area investigations and land transects. *Bull. Ecol. Res. Comm.* No. 9, Lund.
- HAYNE, D. W. 1949. An examination of the strip census method for estimating animal populations. *J. Wildl. Mgmt.* 13: 145-157.
- HICKEY, J. J. 1943. A guide to bird watching. London, Oxford Univ. Press.
- JÄRVINEN, O. AND R. VÄISÄNEN. 1975. Estimating relative densities of breeding birds by the line transect method. *Oikos* 26: in press.
- LEOPOLD, A. 1933. Game management. New York, Charles Scribner's Sons.
- MANNES, P. AND R. ALPERS. 1975. Über Fehlergrößen bei Siedlungsdichte-Untersuchungen an höhlenbrütenden Singvögeln nach der Kartierungsmethode. *J. für Ornithol.* 116: 308-314.
- MERIKALLIO, E. 1946. Über regionale Verbreitung und Anzahl der Landvögel in Süd-und Mittelfinnland, besonders in deren Östlichen Teilen, im Lichte von quantitativen Untersuchungen. I. Allgemeiner Teil. *Ann. Zool. Soc. Vanamo*, Tom 12(1): 1-140.
- . 1958. Finnish birds. Their distribution and numbers. *Fauna Fennica* 5: 1-181.
- PALMGREN, P. 1930. Quantitative Untersuchungen Über die Vogelfauna in den Wäldern Südfinnlands. *Acta Zool. Fennica* 7: 1-218.
- ROBBINS, C. S. 1970. Recommendations for an international standard for a mapping method in bird census work. *Audubon Field Notes* 24: 723-726.
- SVENSSON, S. 1974. Interpersonal variation in species map evaluation in bird census work with the mapping method. *Acta Ornithol.* 14(23): 322-338.
- WILLIAMS, A. B. 1936. The composition and dynamics of a beech-maple climax community. *Ecol. Monogr.* 6: 317-408.

APPENDIX

As a test for the breeding season transect method described in this paper I conducted a field study combining transect and plot map methods on a tract of mixed woodland in the University of Wisconsin arboretum at Madison, Wisconsin in the summer of 1974. I ran 20 traverses along a 1.10 mile transect route through the tract between 18 June and 7 July, and added 30 traverses between 8 July and 17 August. The census data collected on the first 20 traverses are presented in Table 2, and density estimates calculated from them by the total-cue method, the adjusted song-cue method, and the plot map method are presented in Table 3.

All traverses (1 or 2 per day) were made during the first 3 h of daylight while walking at an average speed of 0.70 to 0.80 mph along a well-marked trail that looped through the tract. All detections of movements, call notes, and songs for each species were tallied on prepared sheets in columns representing 10-foot strips to 100 feet, then a 100-foot and a 200-foot strip to 400 feet. All detections were also recorded as colored symbols on strip maps of the route to provide the basis for song-frequency measurements. A separate map was used for each five traverses for each species, and the symbols for each traverse were recorded in different colors. The song frequency for a species (column 5 in Table 2) was calculated from these maps by multiplying the number of different colored song symbols in each selected territory (territory crossings during which the bird was singing) by the number of selected territories on the map. The total number of territories (column 6 in Table 2) was my best estimate of the sum of whole and fractional territories lying within the strip.

The values derived by the adjusted song-cue and plot-map methods (columns 2 and 3 respectively in Table 3) correspond closely for most species. As the two are based on different sets of data this correspondence gives credence to the possibility that both reflect the actual density during the census period quite well. It also suggests that the length of the census period, 20 days, was not long enough to reveal any appreciable differences between the maximum density level during the period as measured by the plot-map method and the mean density level for the period as measured by the transect method. Which of the two sets of results is more accurate in terms of the objectives of its respective method rests on the error sources inherent in the two methods as considered in the discussion section of this paper.

Values obtained by the total cue transect method (not adjusted for cue frequency) presented in column 1 of Table 3 are, with two exceptions, lower than those obtained by the other methods, and in a few cases substantially lower. This, of course, is to be expected during the breeding season when resident birds are highly irregular in cue production. In some species it may be attributed in large part to the low detectability of female during the breeding season, but in at least the seven species where song detections (multiplied by 2 to cover females) were used because they gave higher values than the unadjusted values based on

all cues (see footnote 3 in Table 2) it clearly involved nonsinging resident males. When adjusted for song frequency (column 5 in Table 2) these values are equated with the song-cue transect values. The total-cue and song-cue methods, of course, cover nonterritorial birds deliberately omitted in the plot-map method.

The song-frequency indices used for transect censuses in this paper (occurrence in 4-6 min periods) presumably reflect species-characteristic behavioral traits that will vary in more or less predictable patterns for each species with time of day and stage of the nesting cycle. Individual variations will inevitably occur but, roughly standardized for time of day when frequencies are not changing rapidly, mean values for the populations on a census tract may be expected to show predictable progressive changes as the breeding season advances. If this prediction can be verified with the accumulation of data, it may be possible to apply values for a specified segment of the season to song counts along a census route without recording local song frequencies for every operation.

Song frequencies for 16 species on the Madison census tract are presented in Table 4 for five periods between 18 June and 17 August of 1974. Ten traverses were run in each period to provide sample sizes of 10x the number of sample territories for each species. Incidence values (frequencies) declined for most species as the season advanced. Records for early June would doubtless reveal higher frequencies for these species. Irregular fluctuations presumably reflect the smallness of the sample sizes.

TEST GRID AND RECAPTURE POINTS

Figure 1 shows a 12x12 grid of dots. The columns are labeled 1 through 12 at the top, and the rows are labeled A through K on the left. A shaded region is highlighted, consisting of dots at the following coordinates (row, column): (7,1), (7,2), (7,3), (8,1), (8,2), (8,3), (8,4), (9,1), (9,2), and (9,3). This shaded region forms an L-shape that is 3 units wide and 4 units high.

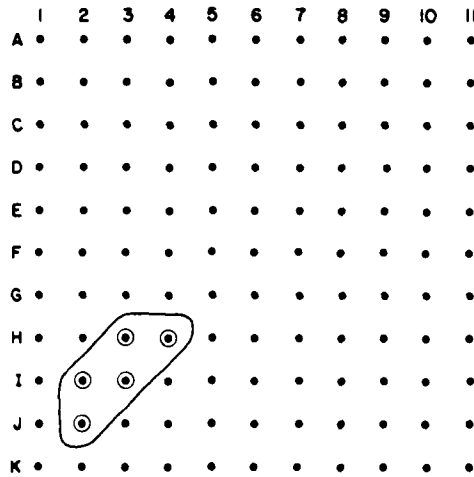
Figure 1 shows a 12x12 grid of dots. The columns are labeled 1 through 11 at the top, and the rows are labeled A through K on the left. A shaded region is drawn around the dots at (5,6), (6,6), (6,7), and (7,6). The dots at (5,6) and (6,6) are also marked with a small circle.

A 12x12 grid of dots. The columns are labeled 1 through 12 at the top, and the rows are labeled A through K on the left. A shaded, irregular region is drawn around three dots. The dots are located at the intersection of column 4 and row E, column 5 and row E, and column 6 and row G. The shaded region is roughly elongated from top-left to bottom-right, encompassing these three dots.

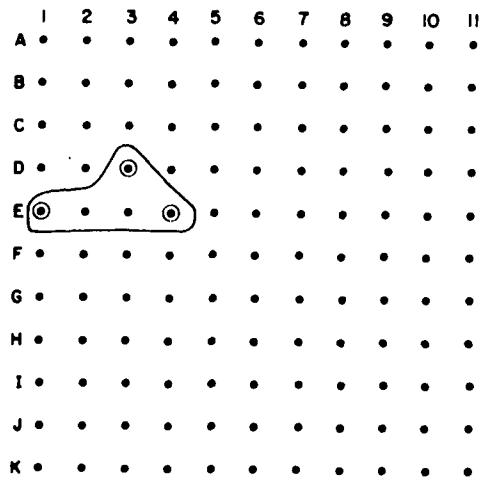
[illegible]

[illegible][illegible][illegible]

Number: 89
Species: Peromyscus leucopus



Number: 109
Species: Peromyscus leucopus



APPENDIX H:

RECORDING AND ANALYSIS OF FIELD OBSERVATIONS

The following hypothetical example shows how field observations of birds should be recorded and analyzed. The study area (a control grid) is a 16-hectare (39.5-acre) grid. For simplification, only five species are involved: the Cardinal, Blue Jay, Redwinged Blackbird, Grackle, and Carolina Wren. After drawing and copying the map of the grid, a series of symbols is devised to simplify recording of field observations:

1 = Cardinal

2 = Blue Jay

3 = Redwinged Blackbird

4 = Grackle

5 = Carolina Wren

yg = young (if "yg" is not next to the number representing the species, the bird was an adult)

♂ = male

♀ = female (if no symbol for sex is given, then the species does not show sexual dimorphism and sex cannot be determined)

N = active nest

V = vocalizing

R = roosting

F = feeding

T = territorial dispute

→ = direction of flight: beginning of arrow is the point of takeoff, the point of the arrow is the landing point, dotted line after arrow indicates bird continued flight and visual contact was lost or the bird left the grid.

AD-A086 526

CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/6 6/6
GUIDELINES FOR TERRESTRIAL ECOSYSTEM SURVEY. (U)

MAY 80 W D SEVERINGHAUS
CERL-TR-N-89

NL

UNCLASSIFIED

3 of 3
40
AD-A086 526



END

DATE

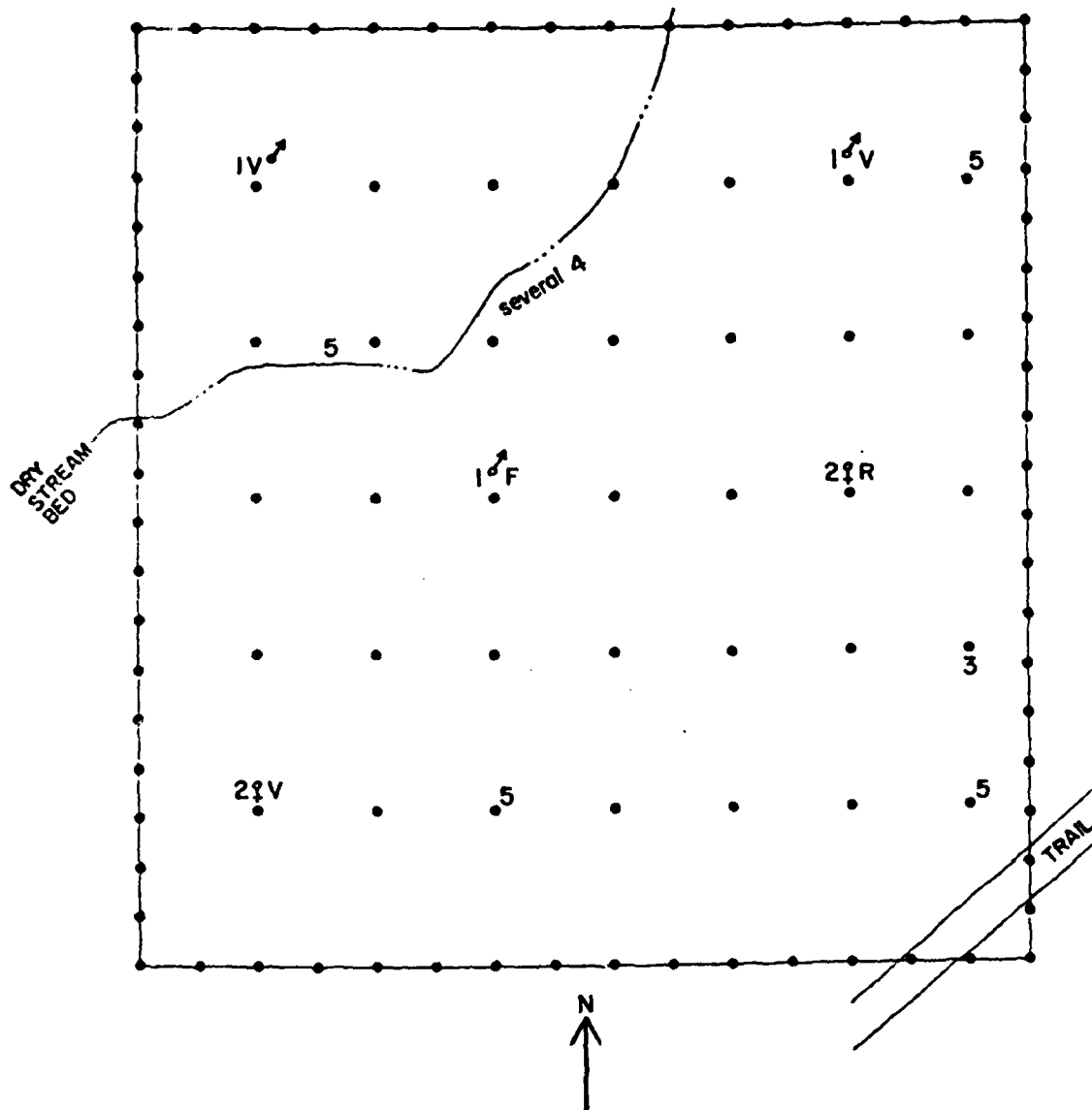
FILED

8-80

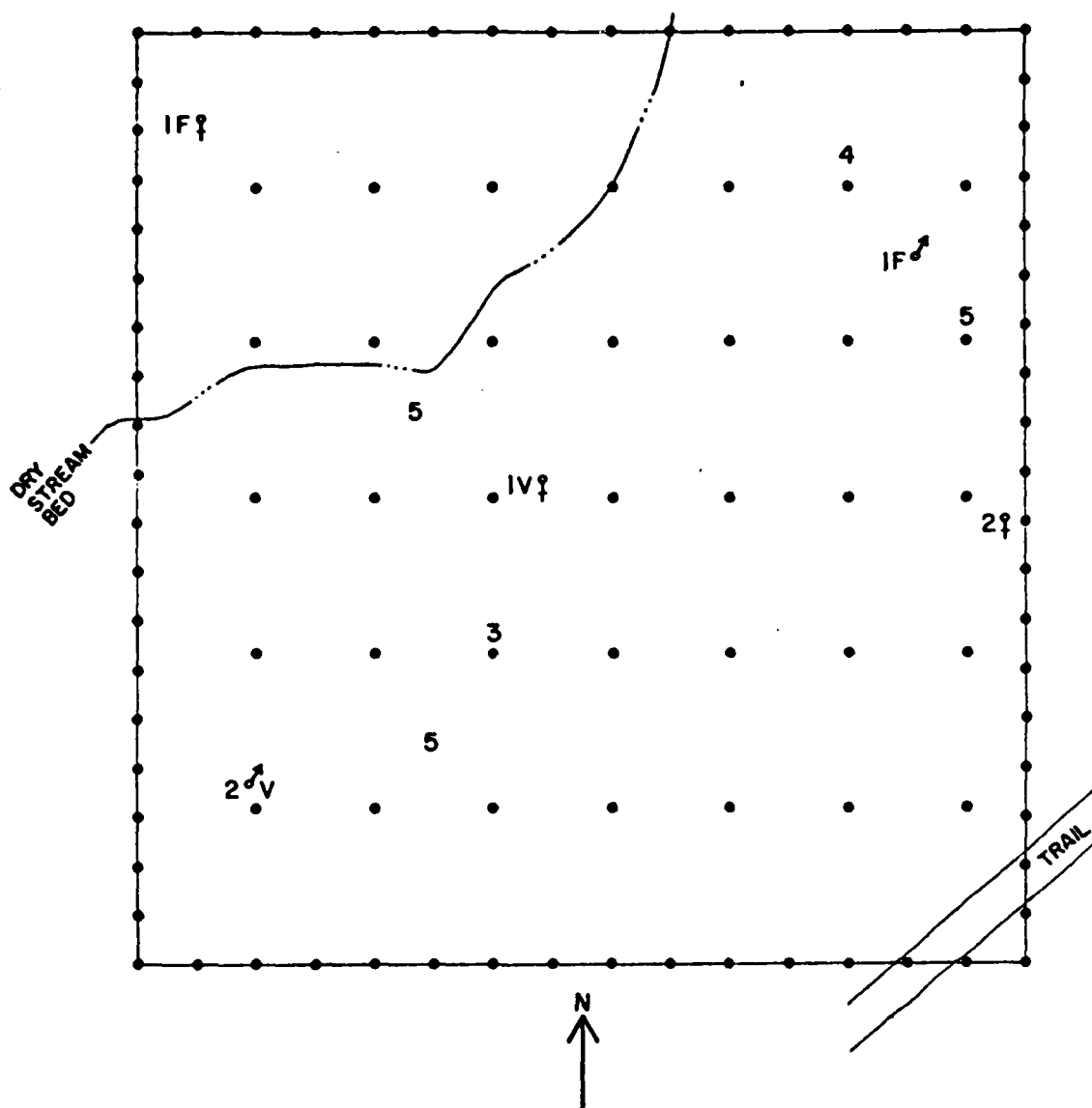
DTIC

The hypothetical observations were made according to the plan previously described, and each day's "recordings" are given (see Appendix H, pp 192-206). From these data sheets a composite of the recordings for each species was made (Appendix H, pp 207-211).

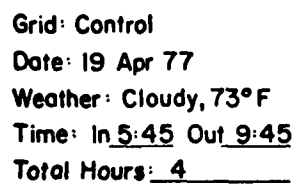
The hypothetical results indicate that there are three breeding pairs of Cardinals (six adult individuals); three breeding pairs of Blue Jays (six adult individuals), with one transient; four breeding pairs of Carolina Wren (eight adult individuals); and a number of transient Redwinged Blackbirds and Grackles.

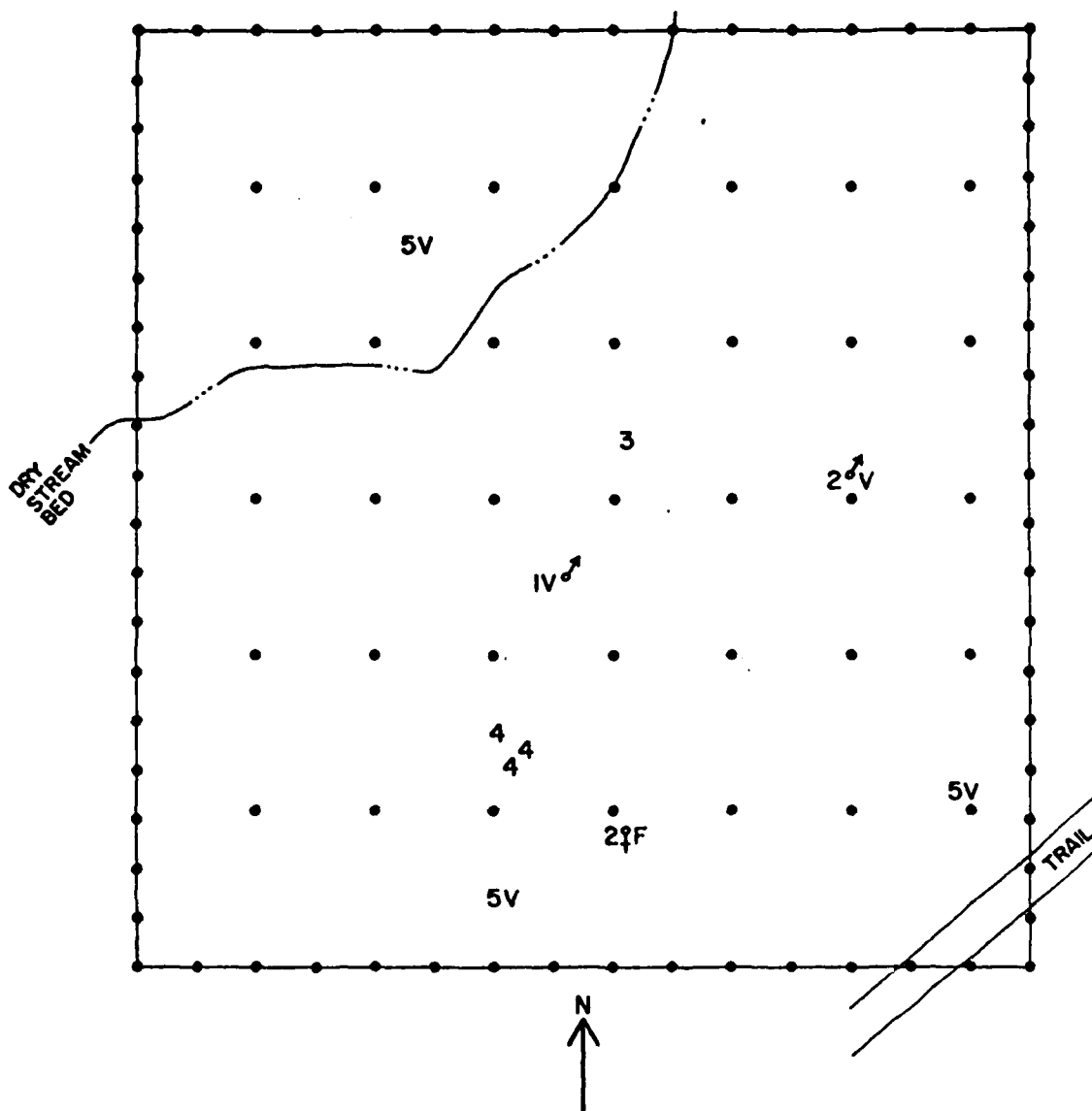


Grid: Control
 Date: 17 Apr 77
 Weather: Sunny, 83°F
 Time: In 5:30 Out 9:30
 Total Hours: 4

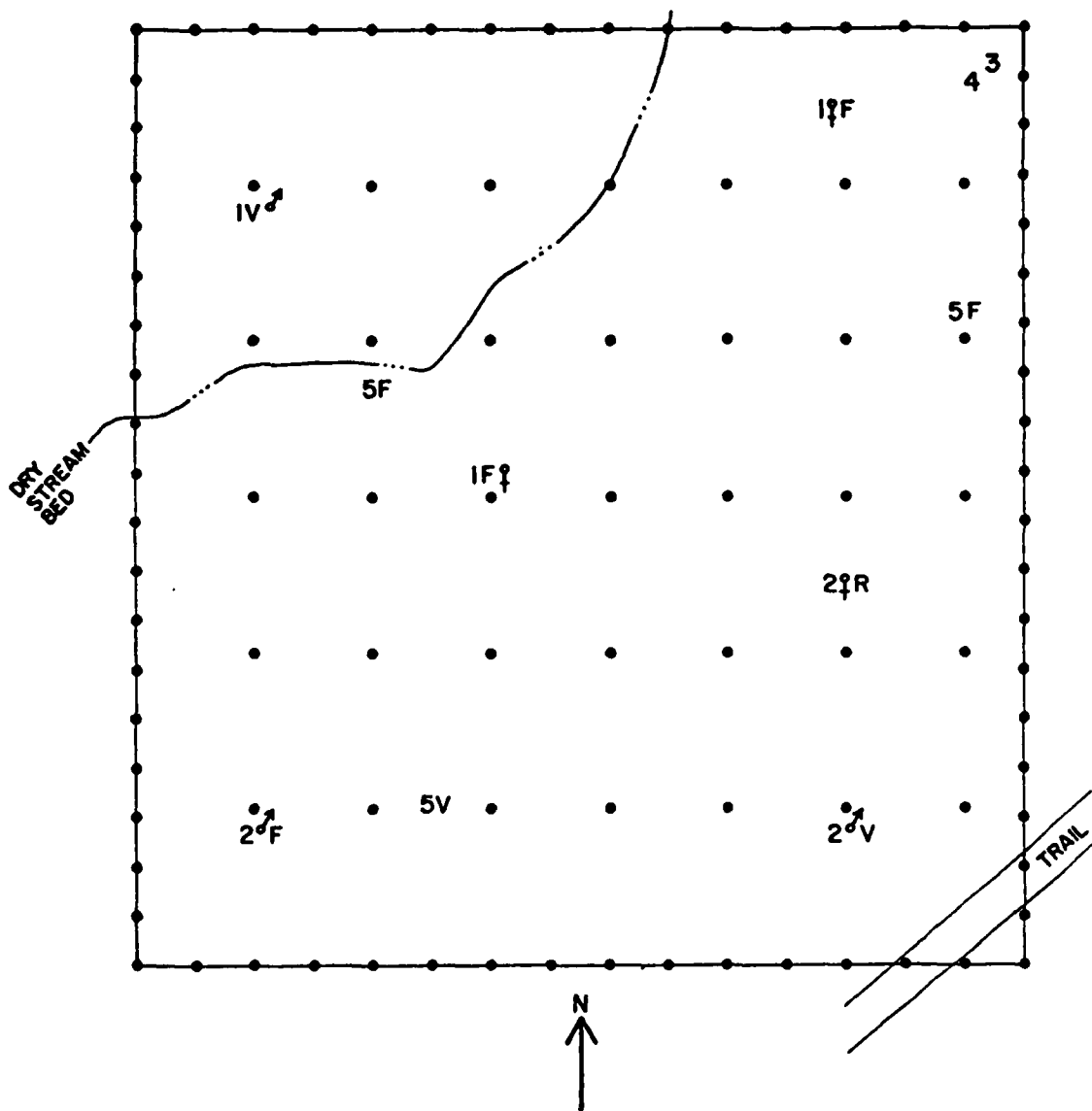


Grid: Control
 Date: 18 Apr 77
 Weather: Partly Cloudy, 77°F
 Time: In 5:15 Out 9:15
 Total Hours: 4

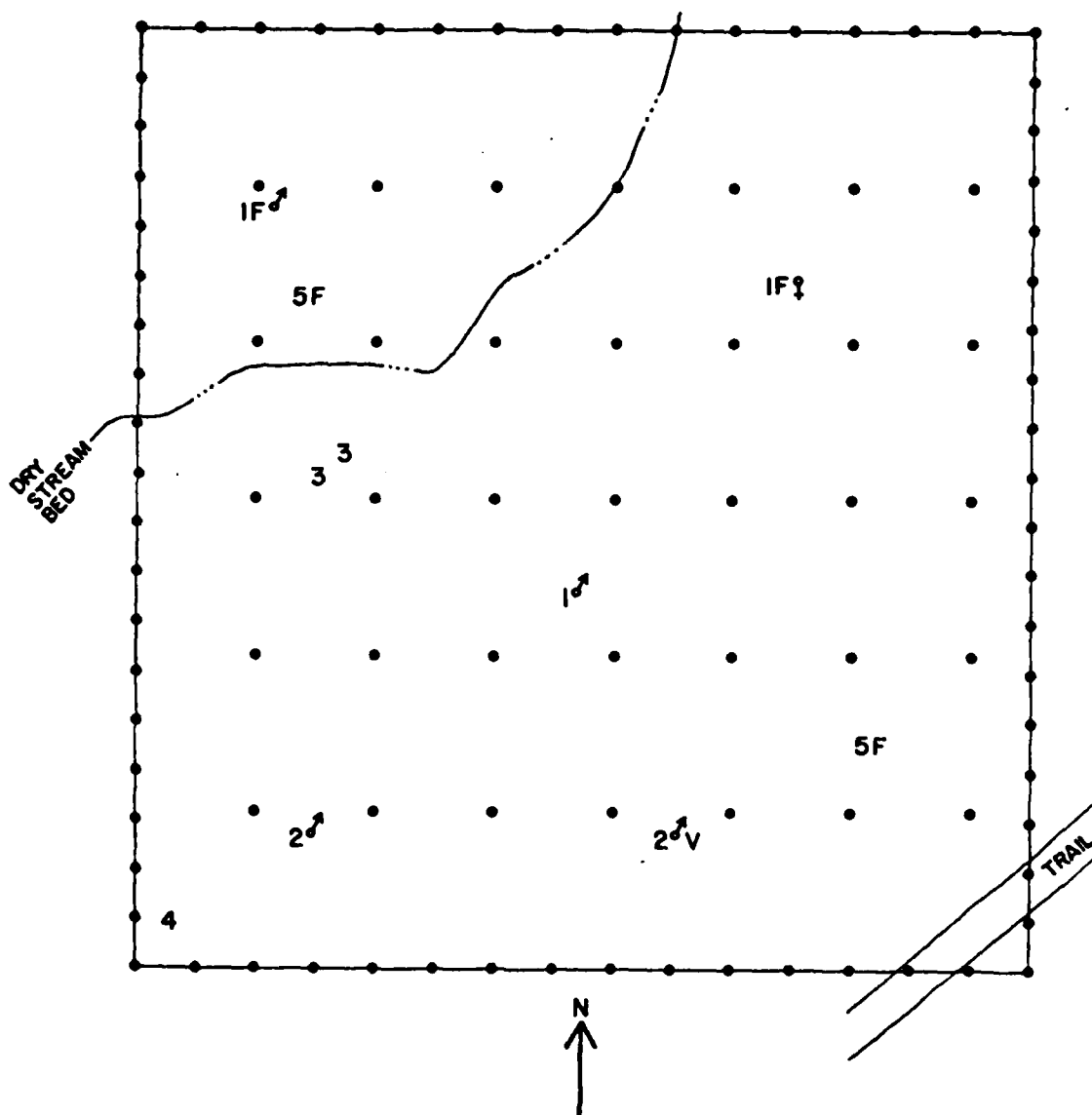




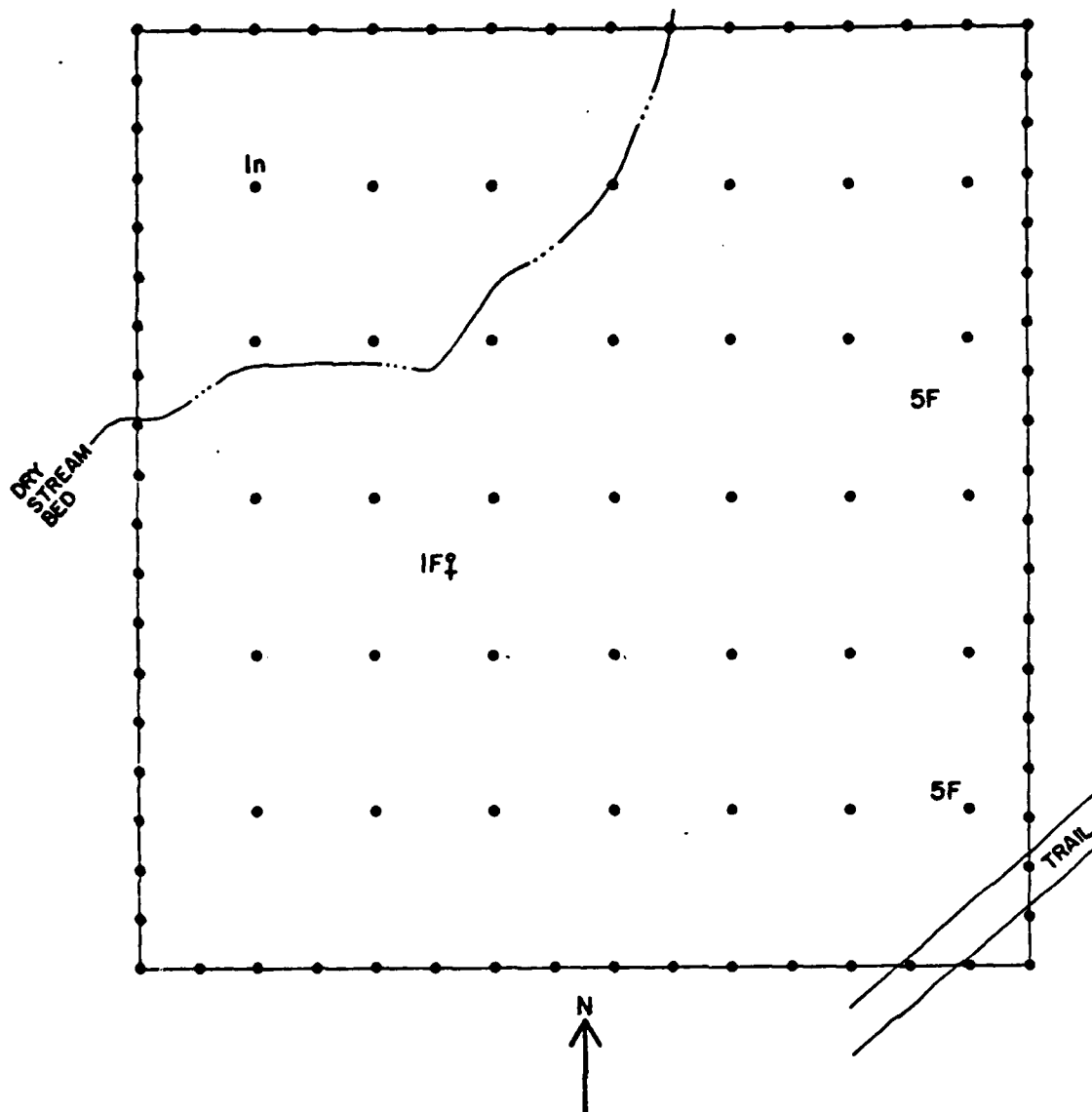
Grid: Control
 Date: 12 May 77
 Weather: Sunny, 85°F
 Time: In 5:30 Out 9:30
 Total Hours: 4



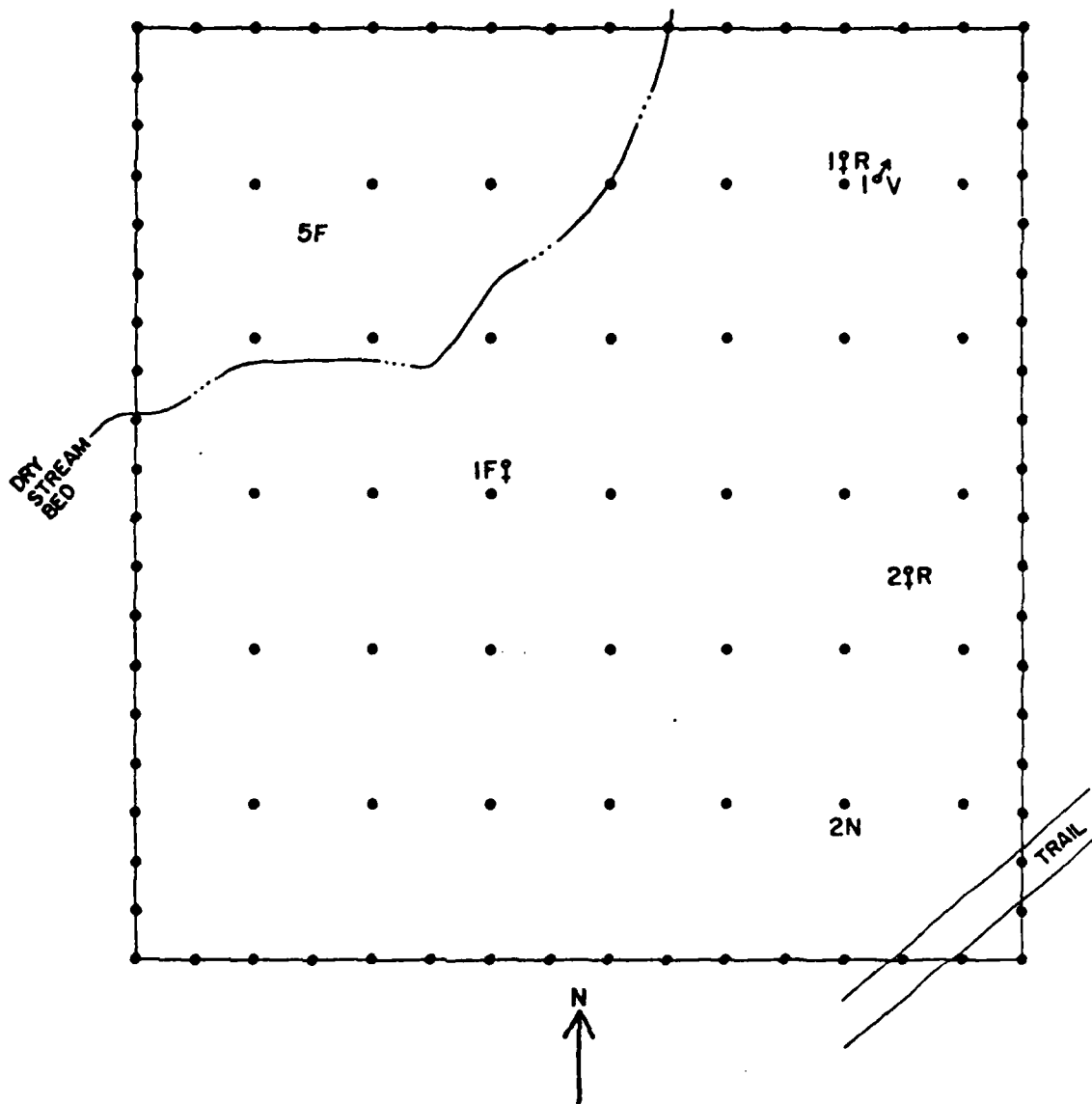
Grid: Control
 Date: 13 May 77
 Weather: Sunny, 84°
 Time: In 5:30 Out 9:30
 Total Hours: 4



Grid: Control
 Date: 14 May 77
 Weather: Sunny, 86°F
 Time: In 5:30 Out 9:30
 Total Hours: 4



Grid: Control
 Date: 5 Jun 77
 Weather: Partly Cloudy, 86°F
 Time: In 5:30 Out 9:30
 Total Hours: 4



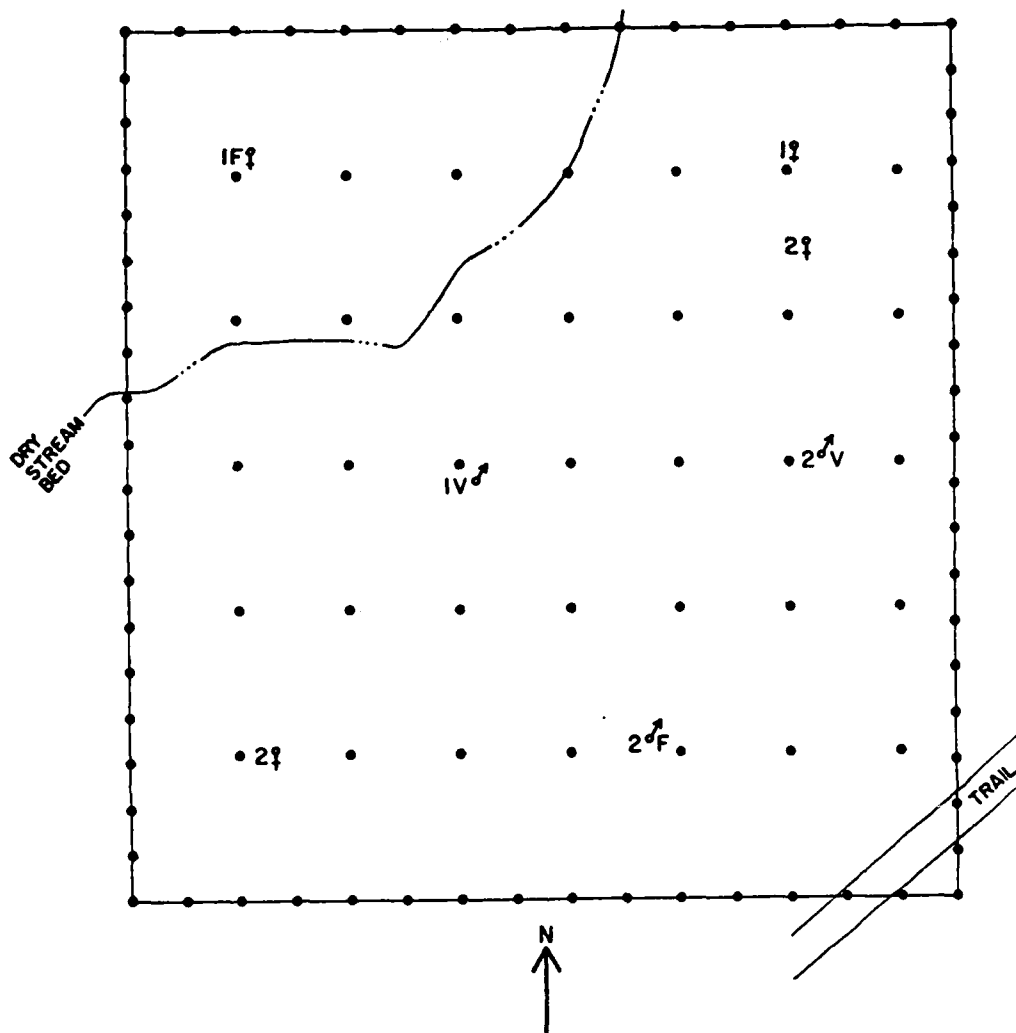
Grid: Control

Date: 6 Jun 77

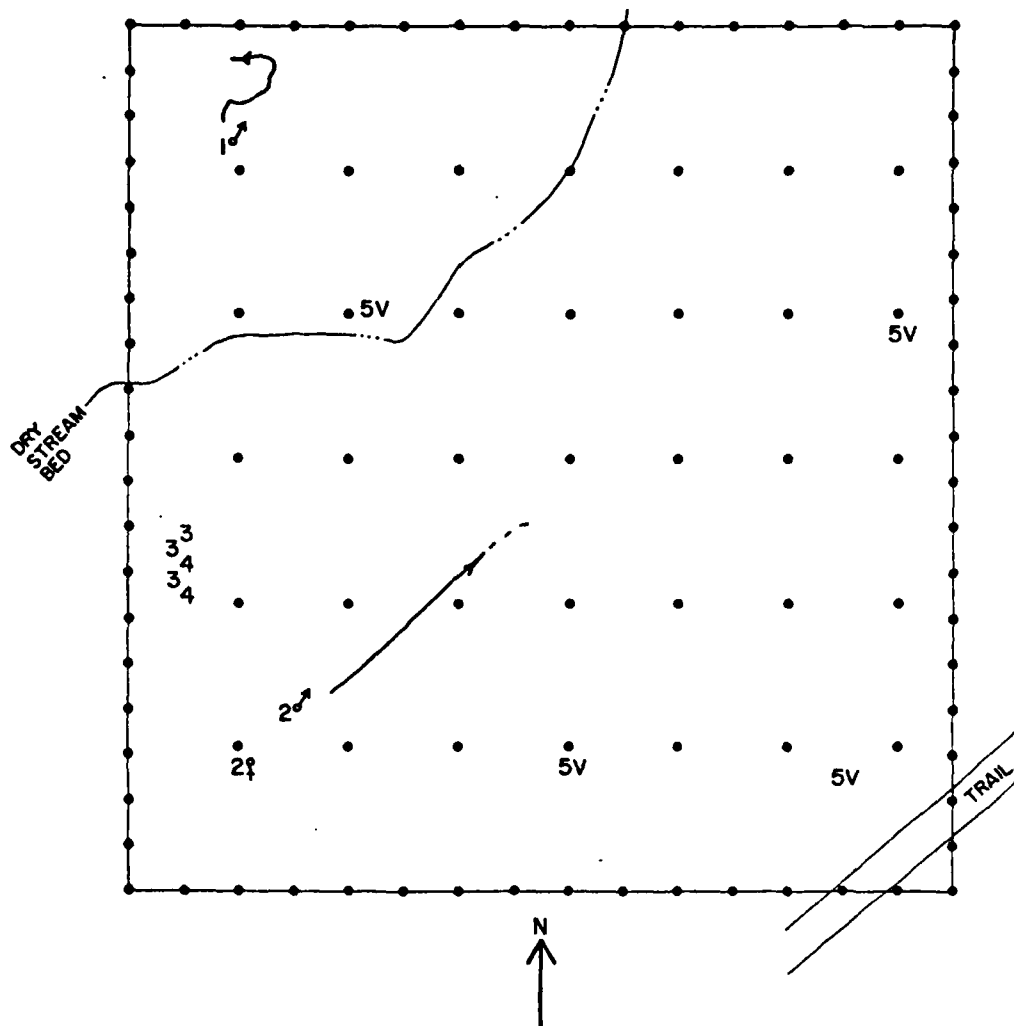
Weather: Partly Cloudy, 86°F

Time: In 5:30 Out 9:30

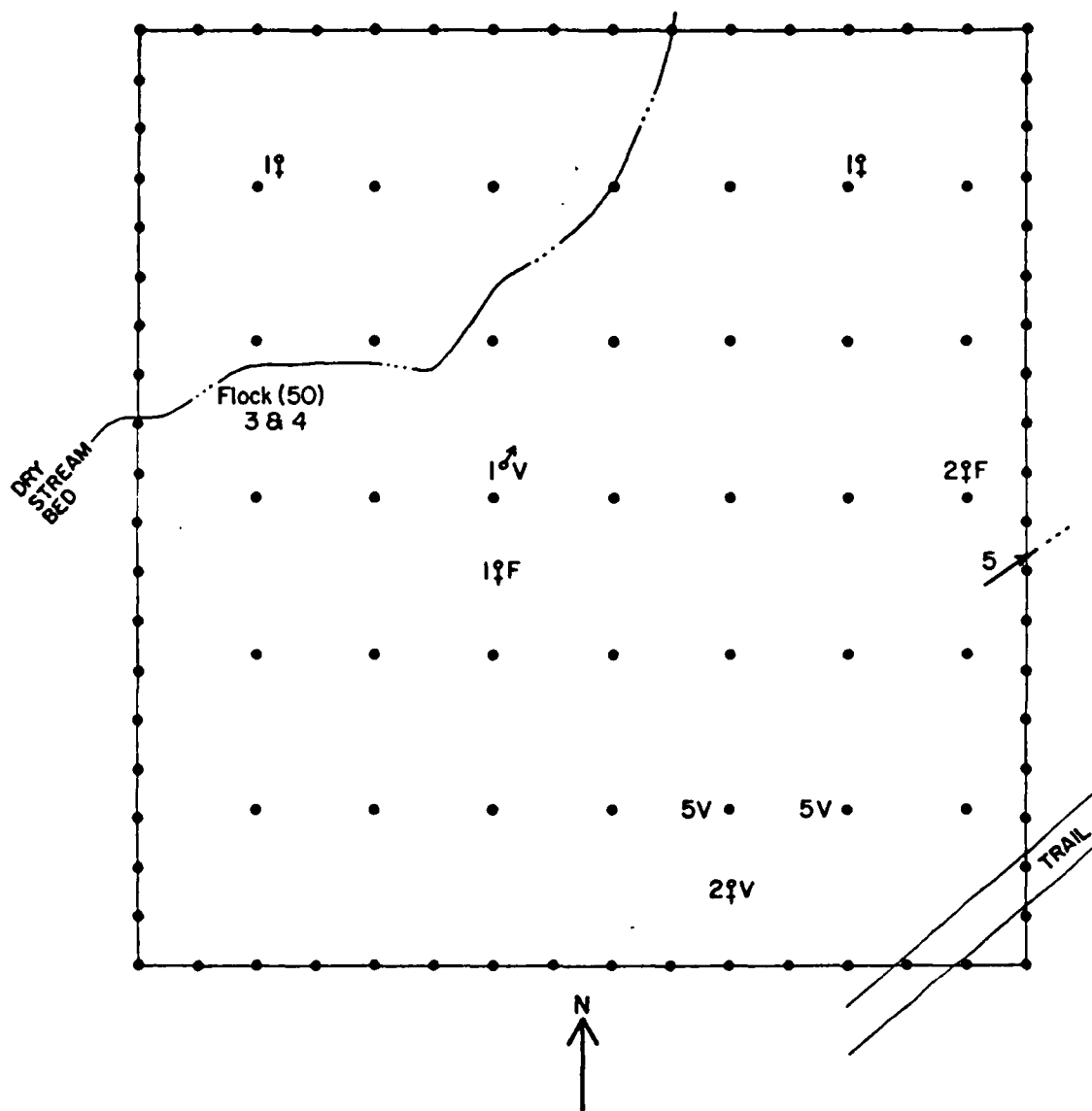
Total Hours: 4



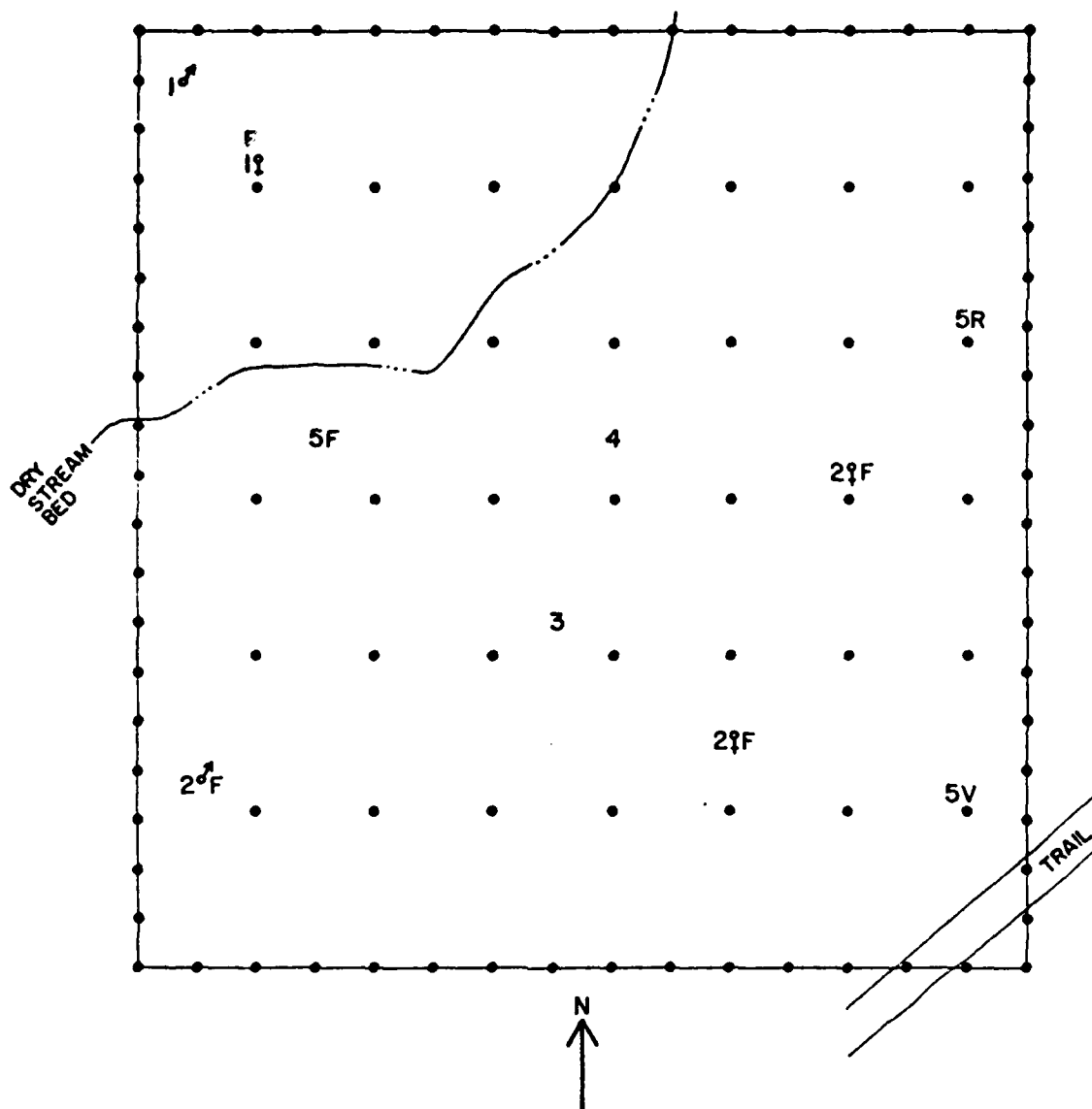
Grid: Control
 Date: 7 Jun 77
 Weather: Partly Cloudy, 87°F
 Time: In 5:30 Out 9:30
 Total Hours: 4



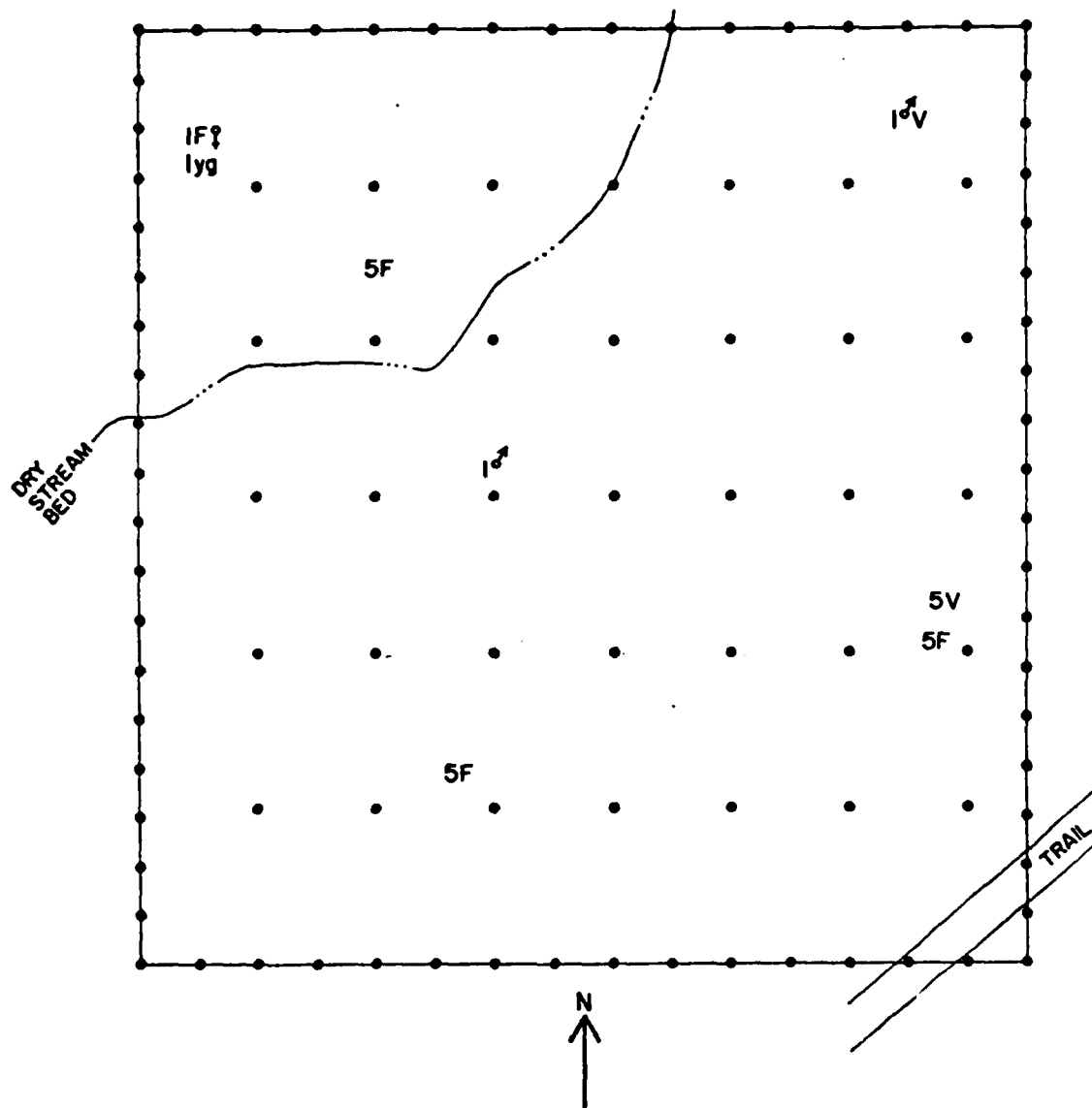
Grid: Control
 Date: 10 Jun 77
 Weather: Sunny, 86° F
 Time: In 5:30 Out 9:30
 Total Hours: 4



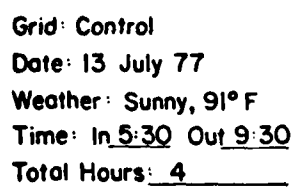
Grid: Control
 Date: 11 Jun 77
 Weather: Sunny, 85° F
 Time: In 5:30 Out 9:30
 Total Hours: 4

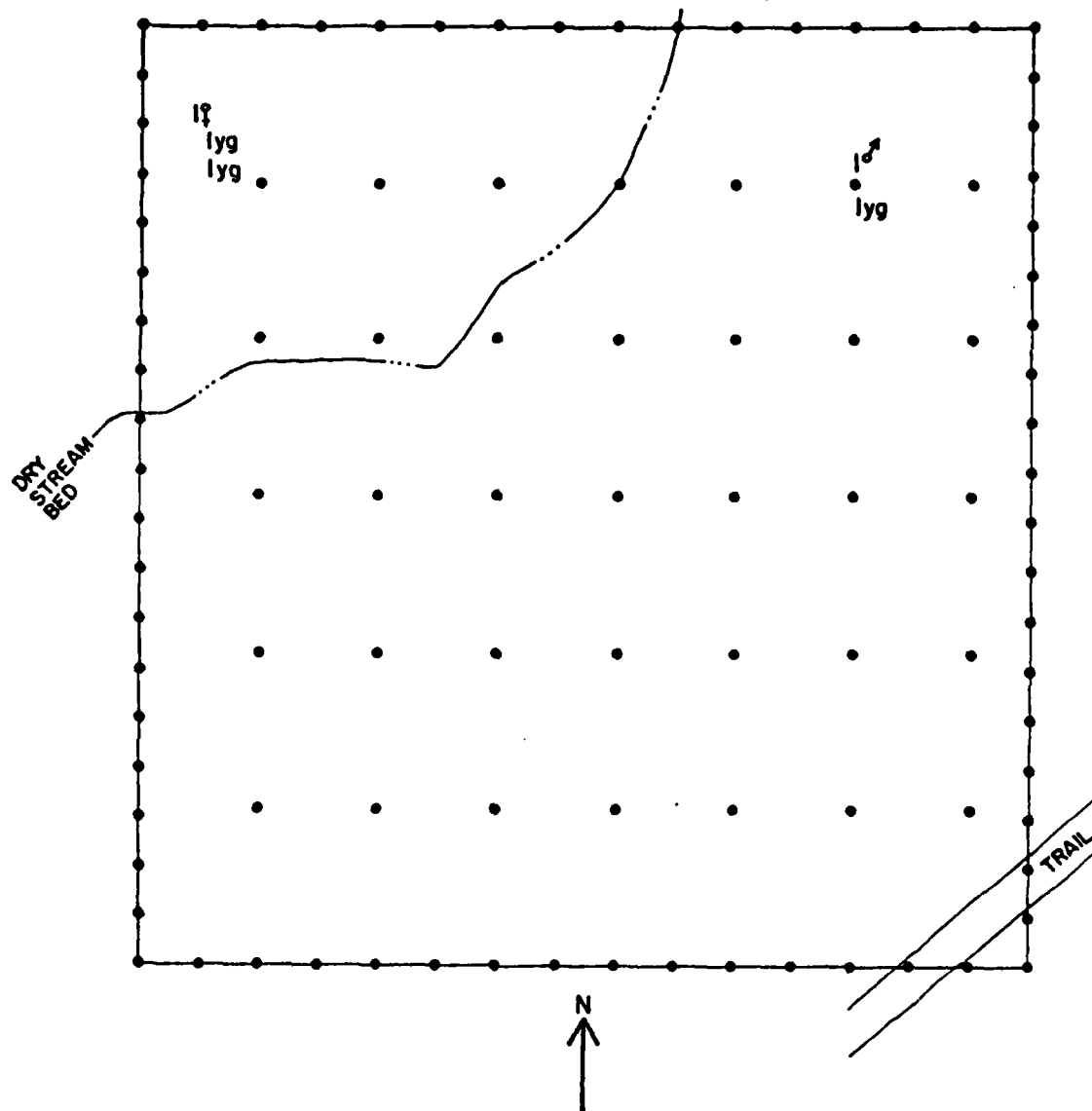


Grid: Control
 Date: 12 Jun 77
 Weather: Sunny, 86°F
 Time: In 5:30 Out 9:30
 Total Hours: 4

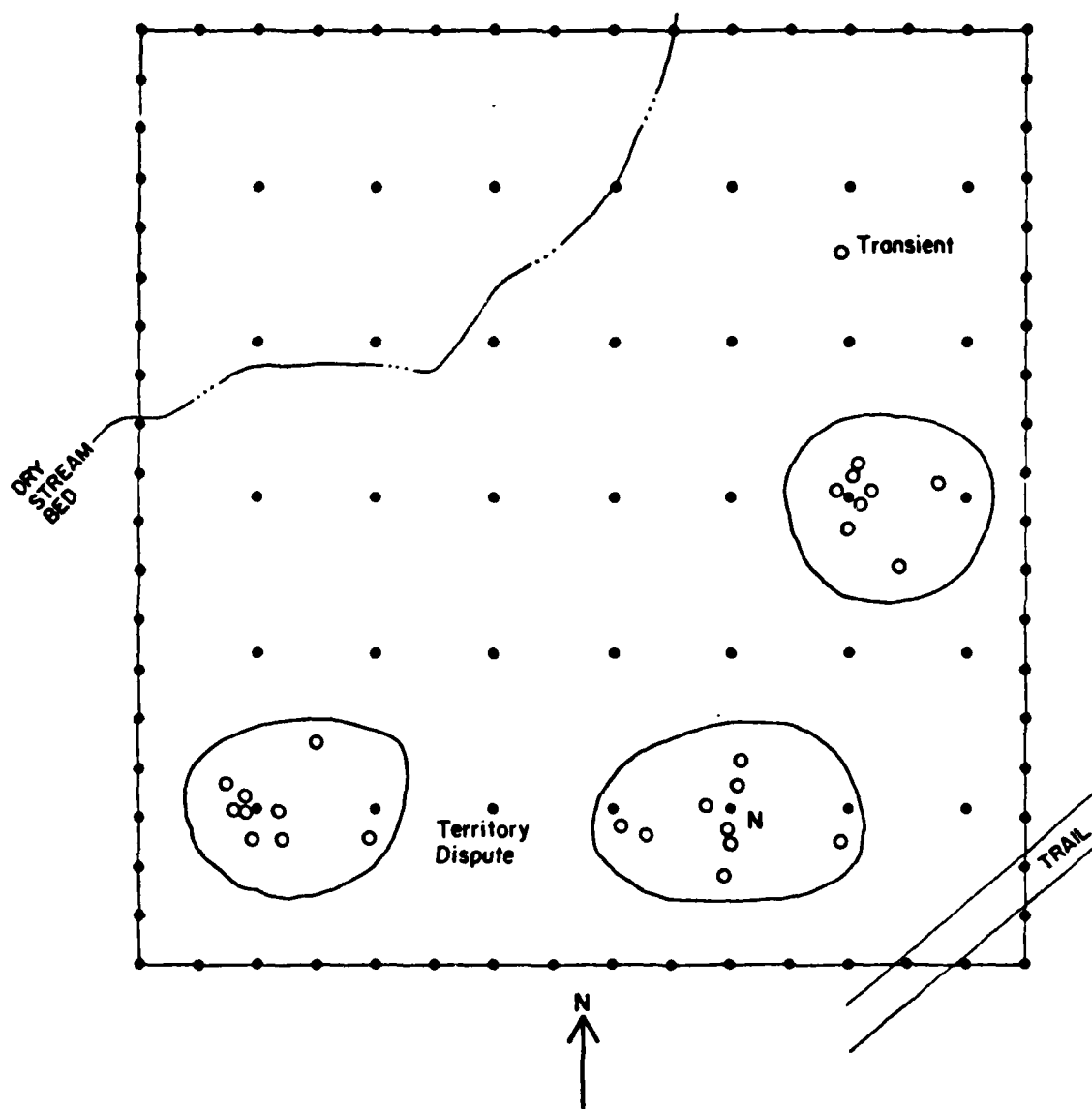


Grid: Control
 Date: 12 July 77
 Weather: Sunny, 89°F
 Time: In 5:30 Out 9:30
 Total Hours: 4

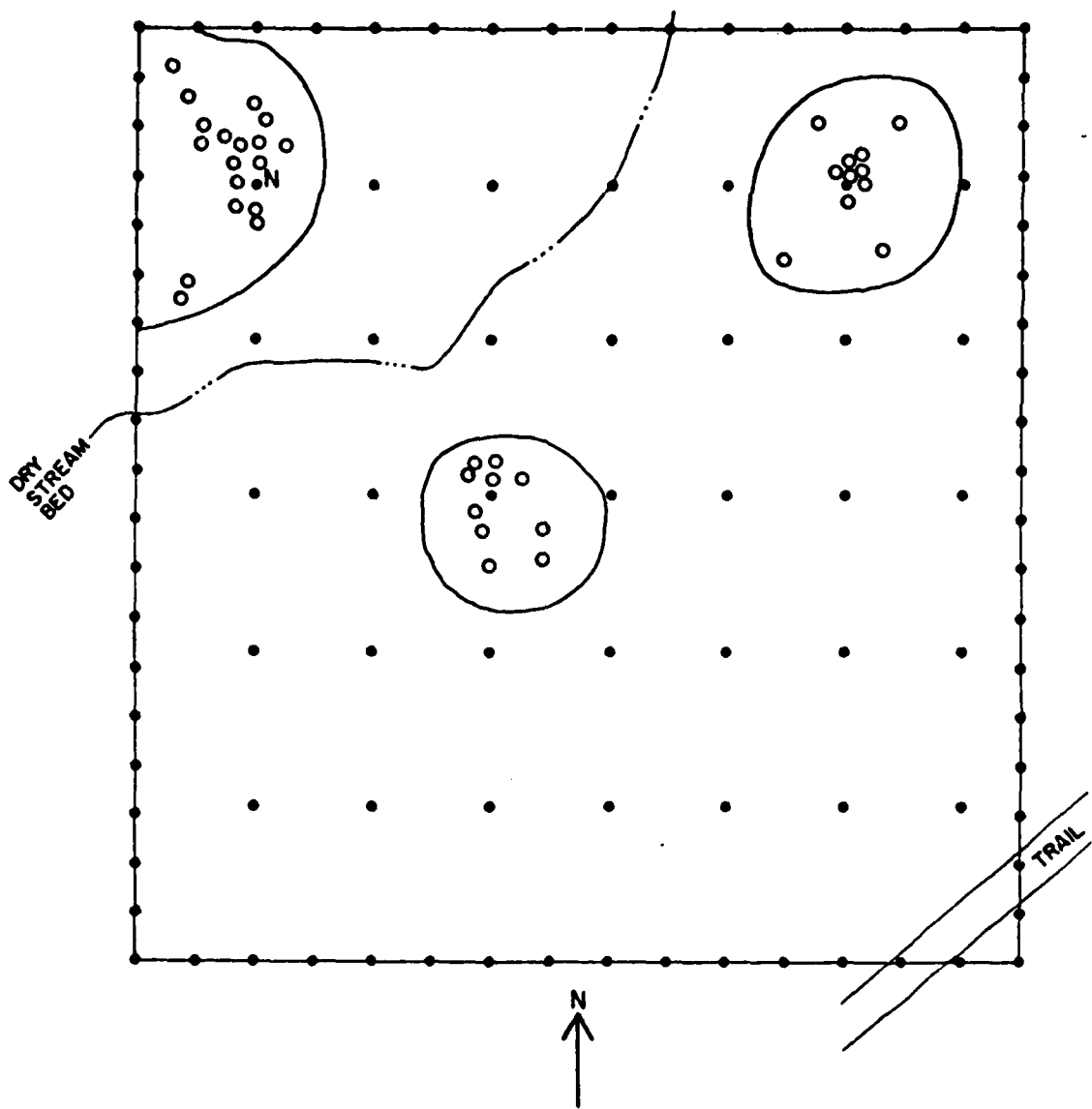




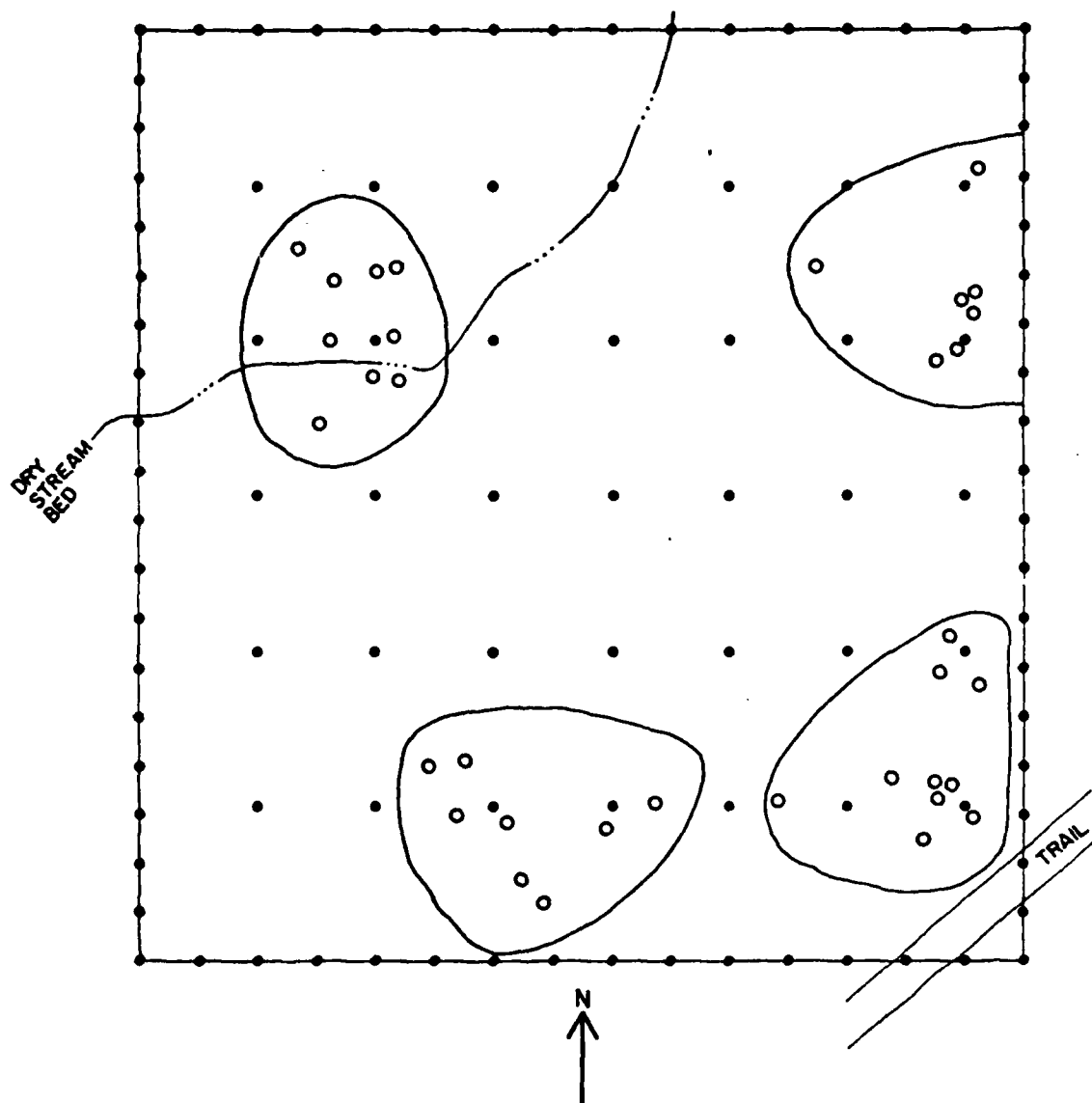
Grid: Control
Date: 14 July 77
Weather: Rain, Drizzle, 85° F
Time: In 5:30 Out 9:30
Total Hours: 4



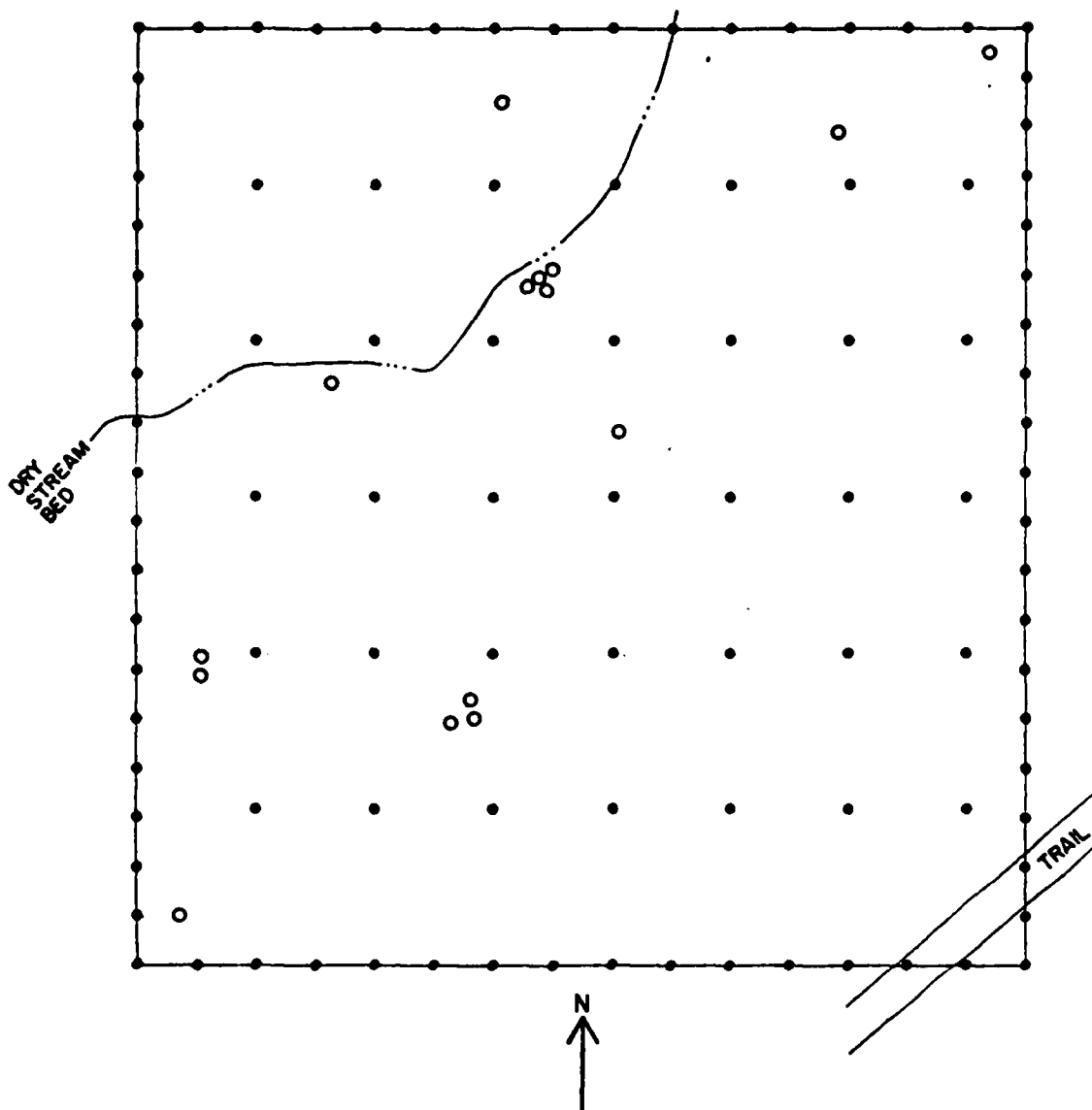
Species: Blue Jay



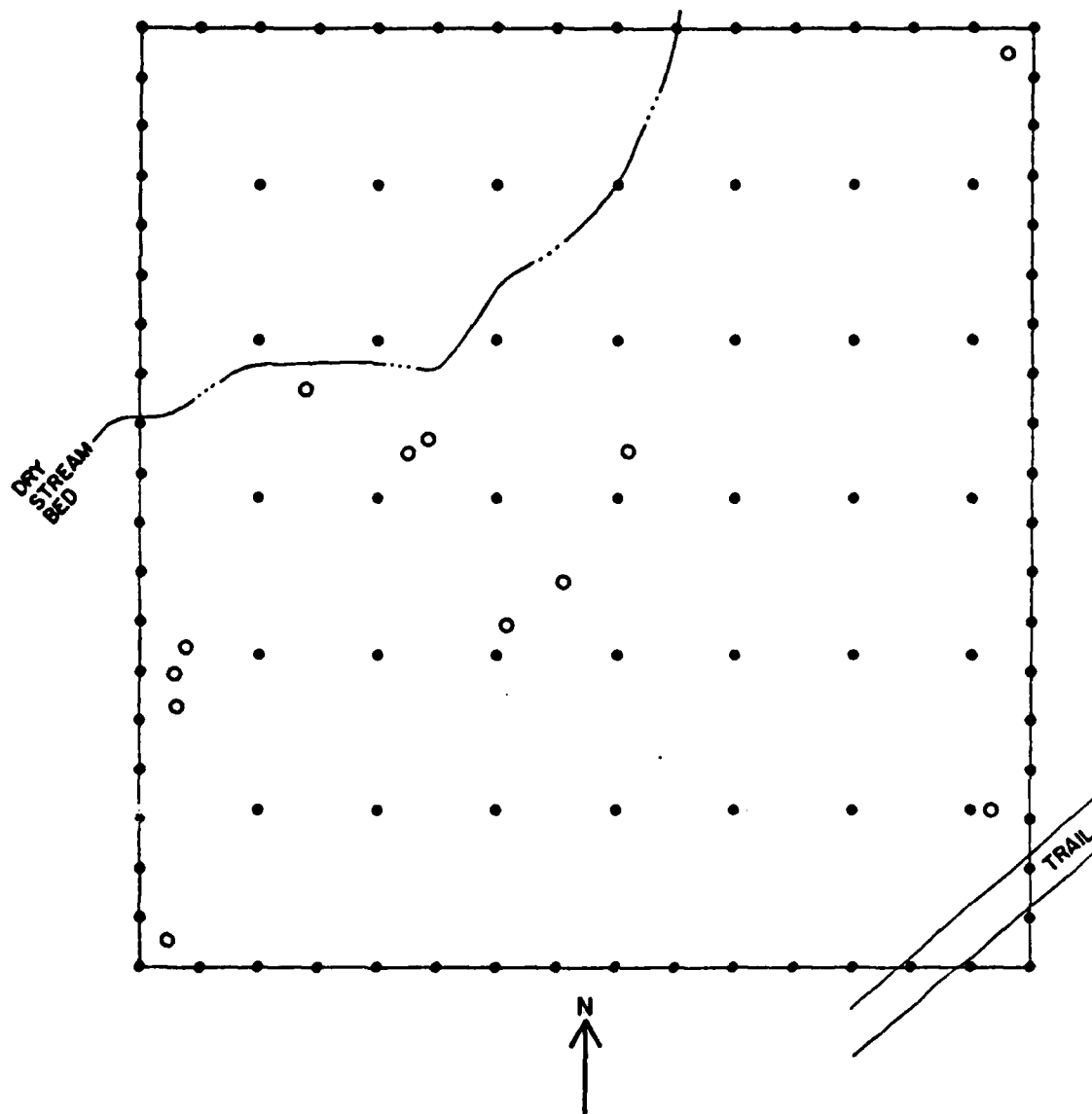
Species: Cardinal



Species: Carolina Wren



Species: Grackle



Species : Redwinged Blackbird

CERL DISTRIBUTION

Chief of Engineers
ATTN: Tech Monitor
ATTN: DAEN-RD
ATTN: DAEN-MP
ATTN: DAEN-ZC
ATTN: DAEN-CW
ATTN: DAEN-RM
ATTN: DAEN-CCP
ATTN: DAEN-ASI-L (2)

US Army Engineer Districts

ATTN: Library
Alaska
Al Batin
Albuquerque
Baltimore
Buffalo
Charleston
Chicago
Detroit
Far East
Fort Worth
Galveston
Huntington
Jacksonville
Japan
Jidda
Kansas City
Little Rock
Los Angeles
Louisville
Memphis
Mobile
Nashville
New Orleans
New York
Norfolk
Omaha
Philadelphia
Pittsburgh
Portland
Riyadh
Rock Island
Sacramento
San Francisco
Savannah
Seattle
St. Louis
St. Paul
Tulsa
Vicksburg
Walla Walla
Wilmington

US Army Engineer Divisions

ATTN: Library
Europe
Huntsville
Lower Mississippi Valley
Middle East
Middle East (Rear)
Missouri River
New England
North Atlantic
North Central
North Pacific
Ohio River
Pacific Ocean
South Atlantic
South Pacific
Southwestern

Waterways Experiment Station

ATTN: Library

Cold Regions Research Engineering Lab

ATTN: Library

US Government Printing Office

Receiving Section/Depository Copies (2)

Defense Technical Information Center

ATTN: DDA (12)

Engineering Societies Library

New York, NY

FESA, ATTN: Library

ETL, ATTN: Library

Engr. Studies Center, ATTN: Library

Inst. for Water Res., ATTN: Library

Army Instl. and Major Activities (COMUS)

DARCOM - Dir., Inst., & Svcs.
ATTN: Facilities Engineer
ARRADCOM
Aberdeen Proving Ground
Army Matls. and Mechanics Res. Ctr.
Corpus Christi Army Depot
Harry Diamond Laboratories
Dugway Proving Ground
Jefferson Proving Ground
Fort Monmouth
Letterkenny Army Depot
Natick Research and Dev. Ctr.
New Cumberland Army Depot
Pueblo Army Depot
Red River Army Depot
Redstone Arsenal
Rock Island Arsenal
Savanna Army Depot
Sharpe Army Depot
Seneca Army Depot
Tobyhanna Army Depot
Tooele Army Depot
Watervliet Arsenal
Yuma Proving Ground
White Sands Missile Range

FORSCOM

FORSCOM Engineer, ATTN: AFEN-FE
ATTN: Facilities Engineers
Fort Buchanan
Fort Bragg
Fort Campbell
Fort Carson
Fort Devens
Fort Drum
Fort Hood
Fort Indiantown Gap
Fort Irwin
Fort Sam Houston
Fort Lewis
Fort McCoy
Fort McPherson
Fort George G. Meade
Fort Ord
Fort Polk
Fort Richardson
Fort Riley
Presidio of San Francisco
Fort Sheridan
Fort Stewart
Fort Wainwright
Vancouver Bks.

TRADOC

HQ, TRADOC, ATTN: ATEN-FE
ATTN: Facilities Engineer
Fort Belvoir
Fort Benning
Fort Bliss
Carlisle Barracks
Fort Chaffee
Fort Dix
Fort Eustis
Fort Gordon
Fort Hamilton
Fort Benjamin Harrison
Fort Jackson
Fort Knox
Fort Leavenworth
Fort Lee
Fort McClellan
Fort Monroe
Fort Rucker
Fort Sill
Fort Leonard Wood

INSCOM - Ch. Instl. Div.

ATTN: Facilities Engineer
Vint Hill Farms Station
Arlington Hall Station

WESTCOM

ATTN: Facilities Engineer
Fort Shafter

MDW

ATTN: Facilities Engineer
Cameron Station
Fort Lesley J. McNair
Fort Myer

HSC

HQ USAHSC, ATTN: HSLO-F
ATTN: Facilities Engineer
Fitzsimons Army Medical Center
Walter Reed Army Medical Center

USACC

ATTN: Facilities Engineer
Fort Huachuca
Fort Ritchie

MTMC

HQ, ATTN: MTMC-SA
ATTN: Facilities Engineer
Oakland Army Base
Bayonne MOT
Sunny Point MOT

US Military Academy

ATTN: Facilities Engineer

USAES, Fort Belvoir, VA

ATTN: FE Mgmt. Br.
ATTN: Const. Mgmt. Br.
ATTN: Engr. Library

Chief Inst. Div., I&SA, Rock Island, IL

USA ARRCOM, ATTN: Dir., Instl. & Svc

TARCOM, Fac. Div.
TECOM, ATTN: DRSTE-LG-F
TSARCOM, ATTN: STSAS-F
NARAD COM, ATTN: ORDNA-F
AMMRC, ATTN: DRXMR-WE

HQ, XVIII Airborne Corps and Ft. Bragg

ATTN: AFZA-FE-EE

HQ, 7th Army Training Command

ATTN: AETTG-DEH (5)

HQ USAREUR and 7th Army

ODCS/Engineer
ATTN: AEAEN-EH (4)

V Corps

ATTN: AETVDEH (5)

VII Corps

ATTN: AETSDEH (5)

21st Support Command

ATTN: AEREH (5)

US Army Berlin

ATTN: AEBA-EN (2)

US Army Southern European Task Force

ATTN: AESE-ENG (5)

US Army Installation Support Activity,

Europe
ATTN: AEUES-RP

8th USA, Korea

ATTN: EAFE
Cdr. Fac Engr Act (8)
AFE, Yongsan Area
AFE, 2D Inf Div
AFE, Area II Spt Det
AFE, Cp Humphreys
AFE, Pusan
AFE, Taegu

DLA ATTN: DLA-WI

USA Japan (USARJ)

Ch. FE Div, AJEN-FE
Fac Engr (Honshu)
Fac Engr (Okinawa)

ROK/US Combined Forces Command

ATTN: EUSA-HHC-CFC/Engr

416th Engineer Command

ATTN: Facilities Engineering

ENR Branch Distribution

Chief of Engineers
ATTN: DAEN-MPO-B
ATTN: DAEN-CWZ-R (3)
ATTN: DAEN-CWR-R (2)
ATTN: DAEN-MPE-I
ATTN: DAEN-MPE-T (10)
ATTN: DAEN-MPR (2)
ATTN: DAEN-RDL
ATTN: DAEN-RDM

Learning Resources Center
US Army Engineer School
ATTN: ATSEN-DT-LD (2)
ATTN: Archives Section/Bldg 270
Ft. Belvoir, VA 22060

Assistant Chief of Engineers
Dept of the Army
ATTN: DAEN-ZCE (10)
Pentagon, Room 1E676
WASH DC 20310

The Army Library (ANRAL-R)
ATTN: Army Studies Section
Room 1A514, The Pentagon
WASH DC 20310

Commander, HQ TRADOC
Office of the Engineer
ATTN: ATEN-ADCSN (3)
ATTN: ATEN-FE-NR (4)
Ft. Monroe, VA 23651

Commander
USA ARRADCOM
ATTN: Fac. Engr/Env. Ofc.
Dover, NJ 07801

Each US Army Engr Dist
ATTN: Environmental Branch
ATTN: Military Planning Section*
*Kansas City, Omaha, Baltimore,
New York, Norfolk, Alaska,
Mobile, Savannah, Los Angeles
Sacramento, Fort Worth

US Army Engr Div, North Central
ATTN: Chief, Engr Div
536 S. Clark St.
Chicago, IL 60605

US Army Engr Div, New England
ATTN: Regulatory Functions
Waltham, MA 02154

Indicated Fac. listed in DA PAM 210-1
ATTN: Facility Engr/Env Office

Director, USA-WES
ATTN: WES-FA
P.O. Box 631
Vicksburg, MS 39181

Commander
ATTN: HQ, HSCM-R
Ft. Sam Houston, TX 77234

Env. Mgmt. Committee
Army Logistics Mgmt. Center
ATTN: DRXMC-MR-1
Ft. Lee, VA 23801

Director
HQ Defense Logistics Agency
ATTN: DLA-OSF (3)
ATTN: DLA-WS (2)
Cameron Station
Alexandria, VA 22314

Commander
193d Inf BDE (CZ)
ATTN: AFZU-FE-E
Miami, FL 34004

Commander
ATTN: Facility Engr/Env Office
Ft. Buchanan, PR 00934

HQ DARCOM
ATTN: DRCIS-A (2)
5001 Eisenhower Ave.
Alexandria, VA 22333

Institute for Water Resources
Kingman Building
ATTN: J. Delli Priscoli
Ft. Belvoir, VA 22060

Commander
ATTN: Facility Engr/Env Office
Ft. Richardson, AK 99505

Commander
ATTN: Facility Engr/Env Office
Schofield Barracks, HI 96857

Commander
ATTN: Facility Engr/Env Office
Ft. Wainwright, AK 99703

Commander
ATTN: Facility Engr/Env Office
Ft. Shafter, HI 96558

Commander
ATTN: Facility Engr/Env Office
Ft. Greely
APO Seattle, WA 98733

Commander
US Army Engr Command, Europe
APO New York, NY 09403

Commander
US Army HQ FORSCOM
ATTN: AFEN-EQ (4)
Ft. McPherson, GA 30330

Aberdeen Proving Ground
ATTN: STEAP-PE-E (2)
Aberdeen Proving Ground, MD 21005

Armament Materiel Readiness Command
ATTN: DRSAR-TSE
Rock Island, IL 61201

Armament R&D Command
ATTN: DRDAR-LCM-S
Dover, NJ 07801

Aviation R&D Command
ATTN: DRDAV-EQP
PO Box 209
St. Louis, MO 63166

Depot System Command
ATTN: DRSDS-S
Chambersburg, PA 17201

Commander
Electronic Proving Ground
ATTN: STEEP-LS-S
Ft. Huachuca, AZ 85613

Communications and Electronics
Materiel Readiness Command
ATTN: DRSEL-PL-ST
Ft. Monmouth, NJ 07703

Electronics R&D Command
ATTN: DELHD-FA
2800 Powder Hill Rd
Adelphi, MD 20783

Installations and Services Activities
ATTN: DRCIS-RI
Rock Island, IL 61201

Missile Materiel Readiness Command
ATTN: DRSMI-KI
Redstone Arsenal, AL 35809

Missile R&D Command
ATTN: DRDMI-MS
Redstone Arsenal, AL 35809

Mobility Equipment R&D Command
ATTN: DRDME-U
Ft. Belvoir, VA 22060

Tank-Automotive Materiel Readiness
Command
ATTN: DRSTA-SP
Warren, MI 48090

Tank-Automotive R&D Command
ATTN: DROTA-J
Warren, MI 48090

Test and Evaluation Command
ATTN: DRSTE-PP-E
Aberdeen Proving Ground, MD 21005

Troop Support and Aviation Materiel
Readiness Command
ATTN: DRSTS-B
4300 Goodfellow Blvd
St. Louis, MO 63120

Dugway Proving Ground
ATTN: STEDP-MT-L-E (2)

Chief, Civil Engr. Research Div.
Air Force Weapons Lab
ATTN: DE
Kirtland AFB, NM 87117

Commander
ATTN: AFESC/DEV (3)
ATTN: AFESC/ECA
ATTN: AFESC/TST
Tyndall AFB, FL 32403

HQ USAF/LEEV
Pentagon
WASH DC 20330

Chief, Naval Operations
ATTN: The Library
Dept of the Navy
WASH DC 20360

US Naval Academy
Political Science Dept
ATTN: Prof Skove
ATTN: Prof Cochran
Annapolis, MD 21402

Transportation Research Board
National Research Council (3)
2101 Constitution Ave.
WASH DC 20418

Office of Mgmt. Svc., MS 110-FAA
800 Independence Ave., SW
WASH DC 20553

Jefferson Proving Ground
ATTN: STEJP-LD-N
Madison, IN 47250

Anniston Army Depot
ATTN: SDSAN-DS-FE
Anniston, AL 36201

Red River Army Depot
ATTN: SDSRR-S
Texarkana, TX 75501

Tooele Army Depot
ATTN: SDSTE-FW
ATTN: SDSTE-NA
ATTN: SDSPU-A
ATTN: SDSTE-UM
ATTN: SDSTE-SE
Tooele, UT 84074

Holston Army Ammunition Plant
ATTN: SARHO-EN
Kingsport, TN 37662

Indiana Army Ammunition Plant
ATTN: SARIN-OR
Charlestown, IN 47111

ENR

Iowa Army Ammunition Plant
ATTN: SAR10-EN
R. R. 1
Middletown, IA 52638

Kansas Army Ammunition Plant
ATTN: SARKA-FE
Parsons, KS 67357

Milan Army Ammunition Plant
ATTN: SARMI-EN
Milan, TN 38358

Newport Army Ammunition Plant
ATTN: SARNE-EN
P.O. Box 121
Newport, TN 37866

Sharpe Army Depot
ATTN: SDSH-ASF
Lathrop, CA 95331

Sierra Army Depot
ATTN: SDSI-FL
Herlong, CA 96113

Tobyhanna Army Depot
ATTN: SDST-AF
Tobyhanna, PA 18466

Rocky Mountain Arsenal
ATTN: SARRM-F
Commerce City, CO 80022

Lake City Army Ammunition Plant
ATTN: SARLC-O-F
Independence, MO 64056

Volunteer Army Ammunition Plant
ATTN: SARVO-O
P.O. Box 1748
Chattanooga, TN 37401

Watervliet Arsenal
ATTN: SARWV-FEE
Watervliet, NY 12189

Savanna Army Depot Activity
ATTN: SDSLE-A
Savanna, IL 61074

Pine Bluff Arsenal
ATTN: SARPB-LTO
Pine Bluff, AR 71611

Yuma Proving Ground
ATTN: STLYP-PL
Yuma, AZ 85364

Chemical Systems Laboratory
ATTN: DRDAR-CLT-E
Edgewood Area
Aberdeen Proving Ground, MD 21010

Lone Star Army Ammunition Plant
ATTN: SARLS-EN
Texarkana, TX 75501

Longhorn Army Ammunition Plant
ATTN: SARLO-O
Marshall, TX 75670

Louisiana Army Ammunition Plant
ATTN: SARLA-S
P.O. Box 30058
Shreveport, LA 71130

Radford Army Ammunition Plant
ATTN: SARRA-IE
Radford, VA 24141

Sacramento Army Depot
ATTN: SDSA-SDF
Sacramento, CA 95813

US Army Operational Test and
Evaluation Agency
ATTN: CSTF-POD
ATTN: CSTF-POP
5600 Columbia Pike
Falls Church, VA 22041

US Army Medical Bioengineering Res.
and Development Laboratory
ATTN: Env. Protection and Res. Div.
Ft. Detrick
Frederick, MD 21701

Institute of Defense Analysis
400 Army-Navy Drive
Arlington, VA 22202

Director
Veterans Administration
Environmental Planning Div. (088C)
810 Vermont Ave., NW
WASH DC 20420

Commander
USA Intelligence and Security Command
ATTN: IALOG-IF
Arlington Hall Station
Arlington, VA 22212

Environmental Protection Agency (EPA)
ATTN: International Env. Referral Cntr.
ATTN: Office of Environmental Review
401 M St., SW
WASH DC 20460

Director
Defense Logistics Agency
Defense Property Disposal Service
ATTN: DPDS-OP
Federal Center
Battle Creek, MI 49016

Chief, Construction and Maintenance
Standards Branch, AAS-580
Federal Aviation Administration
800 Independence Ave., SW
WASH DC 20591

Severinghaus, William D
Guidelines for terrestrial ecosystem survey. -- Champaign, IL : Construction
Engineering Research Laboratory : Springfield, VA : available from NTIS, 1980.
211 p. (Technical report ; N-89)

1. Environmental impact statements. 2. Ecological surveys. I. Title.
II. Series: U.S. Army Construction Engineering Research Laboratory. Technical
report ; N-89.

DATE
FILMED
-8